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OCTOBER 1964

QUARTERLY TECHNICA
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XV-5A LIFT FAN

FLIGHT RESEARCH AIRCRAFT.

15 Contract [redacted] DA44-177-TC-715

9 QUARTERLY TECHNICAL PROGRESS REPORT, NO. 11, 16 May-15 Aug 64.

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5 GENERAL ELECTRIC CO[redacted]

Cincinnati, [redacted] Ohio.

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I. SUMMARY

During the eleventh quarter (May 16, 1964 through August 15, 1964) the lateral control investigation was completed with the static load test successfully completed at San Diego, the necessary hardware manufactured and modification to aircraft number 2 completed, with Edwards vertical thrust stand plus flight testing verification of the increased lateral control power. Full scale wind tunnel testing was completed with aircraft number 1, and the aircraft returned to Edwards for preparation for flight test. Lift fan inlet vane failures were experienced during the wind tunnel tests, modifications designed, manufactured, and tested to establish a flight envelope. Potential longitudinal trim problems were seen during the wind tunnel, a horizontal tail slat and instrumentation boom for measuring tail angle of attack were designed and installed on aircraft number 2. The nose wheel shimmy investigation was completed and modifications accomplished to the aircraft which allowed successful conventional flights to commence May 25, 1964. Initial hover flights began on July 16, 1964. A J85 stall investigation was conducted as a result of several compressor stalls experienced during flight. ~~At the end of this reporting period,~~ two hover flights were successfully accomplished without stalls utilizing J85's in a "stall-free" configuration.

II. DESIGN AND ENGINEERING

A. PROPULSION DESIGN

1. Exit Louver Actuation System

Modification of spare lift fan S/N 003 to incorporate the redesigned exit louver actuation system was completed at Ryan, San Diego, in preparation for static proof testing. During these tests, the forward push rod buckled at 90% load. The design had assumed that the fan rear frame strut walls would provide lateral support and prevent the rod from buckling. As a result of this failure, a new solid pushrod was designed which took full advantage of the available space within the rear frame strut. The new design has a 1.5 buckling margin based on a 9600 pound load without any support being provided by the strut walls. Included in the design was a roller to reduce the frictional loads that are induced when "cam scrubbing" is encountered. Possible overstressing of the new rear frame lugs could result if these frictional forces were higher than anticipated. Both the cam and roller were silver plated to act as a lubricant as well as a protective coating against corrosion.

In addition to the new, stiffer pushrod, a change was made to both ends of the rear frame support strut to increase its load distribution capability. The change, to provide additional precautions against shear buckling, consisted of adding .045 thick doublers to the strut walls extending from the strut ends toward the center of the frame for approximately ten inches.

Dynamic testing revealed that continual pounding had deformed the previously described roller, spreading the edges, thus preventing roller rotation. Rework, in the form of chamfering the edges, was accomplished to the roller.

Inspection of the hardware after testing revealed no cracks or any local buckling or overstress. Further detail examination showed that at one test setting, the

internal "chevron" stops were in contact before the roller and cam contact. The "chevron" was included in the design to provide a back-up stop to prevent exit louver tip clash in the event of a cam or roller failure. Layouts revealed that an interference did exist under those particular conditions and a redesign was included on all fan pushrods. This inadvertent interference, seen during static testing, proved the adequacy of the back-up feature.

2. Exit Louver Stiffening

During ground testing of the XV-5A aircraft at Edwards Air Force Base, several factors affecting roll control were discovered, all of which detracted from the inherent fan roll power. One factor visually observed was the deflection of fan exit louvers due to air loads generated by the fan at high stagger angles. Reduction of these deflections by increasing structural rigidity of exit louvers allows an increase in aircraft roll control power to be realized.

During the portion of the ground testing when the push rods were firmly held by the load links, significant deflections were observed in the aluminum louvers. Tests to measure these deflections show that for a stagger angle of 39° and 100% fan speed, the angle of twist of the louver is 5.3° and at a vector angle of 13° the untwist is less than 1°. Although these deflections are not detrimental to the structural integrity of the louvers nor do they affect the roll acceleration obtained during flightworthiness testing, their reduction or elimination would increase thrust control effectiveness to either add a margin of control reserve or compensate for deficiencies elsewhere in the control system.

As a result of mechanical and aerodynamic analysis (results as per Figure 1), it was decided that the best way to modify the louvers would be to increase the effective skin thickness by putting another skin over the outside. Accordingly, the bow and twist would be reduced by more than half of the previous values. The method used was to take a formed outer skin of the same stock thickness and material as the louver and adhesively bond and rivet it to the louvers.

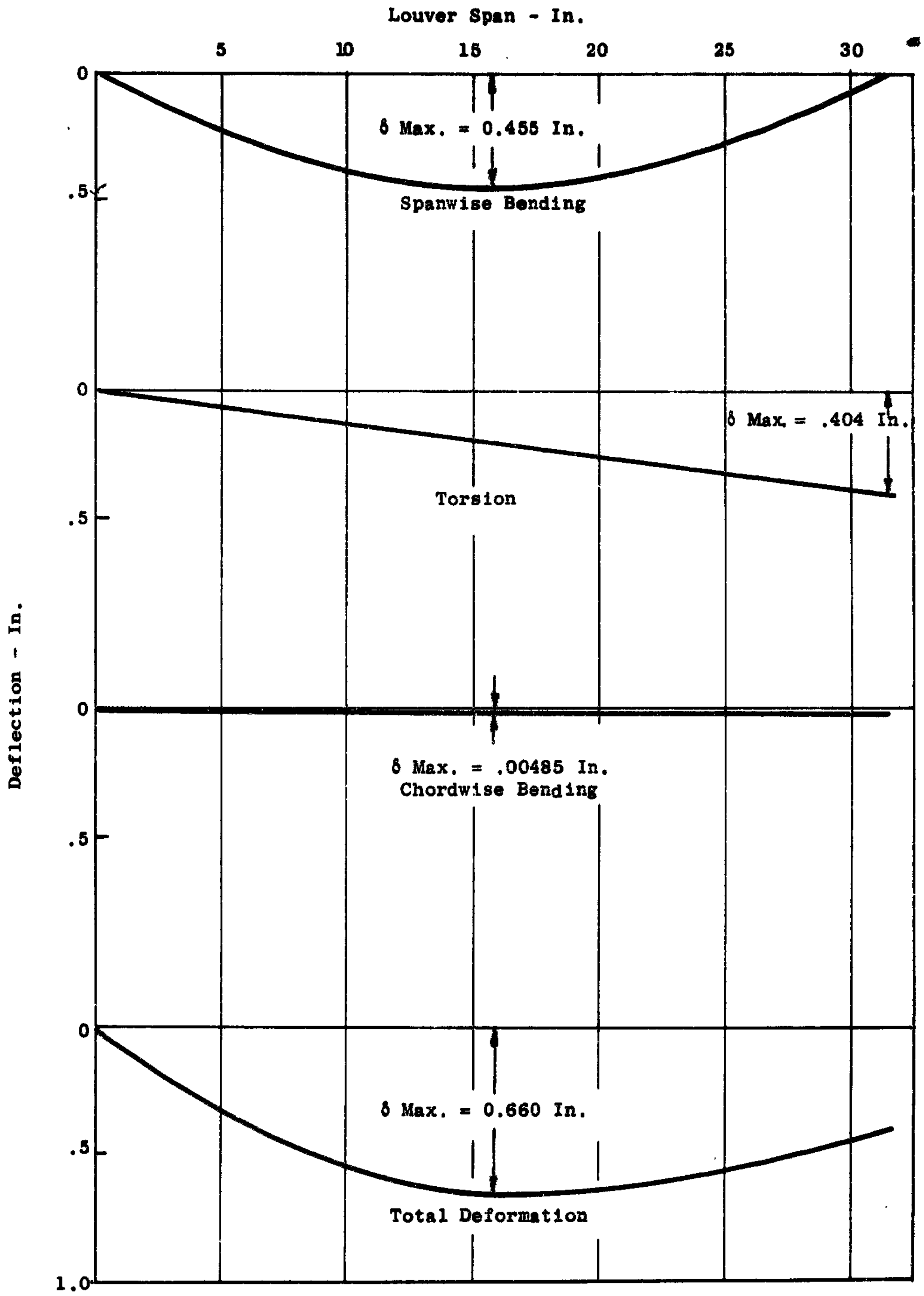


Figure 1. XV-5A Unmodified No. 20 Exit Louver Deformation at 20° Stagger Angle 100% Fan Speed.

By using the same material and thickness, the existing louver skin dies could be utilized, saving both time and expense. Although an exact fit was not obtained between the contact surfaces of the louver and outer shell, it was sufficiently close to obtain a satisfactory bond. Both surfaces were chemically cleaned to remove any contaminants and pre-heated to 150°F prior to the application of resin.

The assembly was then cured in a vacuum bag, with a vacuum of 30 inches of HG, at the following temperatures:

180°F - 2 Hours
250°F - 1 Hour
325°F - 3 Hours

After curing the assembly was allowed to air cool to room temperature before removal from the vacuum bag. Rivets were then added to complete the modification.

Particular care was taken in the selection of a curing cycle which was compatible with the metallurgical properties of the aluminum. The louvers had been given the recommended age cycle to raise the material properties from T_4 to T_6 but the new stiffening shells, having just been formed, were still in the T_4 condition. Consequently, the cycle had to satisfy the curing requirements and raise the properties of the shells without over-aging louvers. The selected cycle comes close to satisfying these requirements but just falls short of attaining the full T_6 condition on the outer shell. Since the addition of the shell dropped the stresses to at least 50% of the previous levels, the slightly reduced properties can be safely tolerated.

The incorporation of the outer shell has a significant beneficial effect on the mechanical performance of the louvers. In addition to reducing the bow and twist, the modification raises the section modulus and provides for an increase in fatigue life.

An evaluation test was made to determine experimentally the deformation of the modified louver under the influence of air loads and show it was significantly less than unmodified louvers.

The test results for the load distribution for the 300 lb. maximum load predicted aerodynamically, indicate following conclusions:

1) A maximum deflection of slightly more than 0.2 inches will occur at approximately mid-span on the trailing edge.

2) The angle of twist between the strut end and the free end will be approximately 1.1°.

From the results it is evident that the maximum louver deformation is spanwise deflection and that the louver modification would fulfill all its objectives.

In June 1964, two sets of louvers were withdrawn from the field for the incorporation of the proposed changes. The modified louvers were then delivered to Edwards Air Force Base and installed on airplane number 2.

3. Circular Inlet Vane Redesign

In May 1964, aircraft number 1, containing lift fans - S/N 005 and 006, was installed in the 40' x 80' wind tunnel at NASA-Ames. After approximately 4 hours of tests up to 80 knots, the forward inboard quadrant on the left hand fan broke loose at the forward 12 O'clock mount and deflected into the fan rotor. The tests were summarily stopped pending analysis and repair of the inlet vane design.

Post macroscopic failure inspection showed the following hardware (vane) damage:

a) Left Hand Forward Inboard

1) Circular vane 12 O'clock mount firmly attached to the strut, but had internal cracks (Figure 2).
2) Heavy wear on torsion damping lug.
3) Damping lug bearing pad (brazed inside the frame strut) broken loose.
4) Elongated hole in frame strut.
5) Circular vane broken loose from 3 O'clock mount.
6) Elongated holes at straight vane attachment to bulletnose dome.
7) Circular vane cracked trailing edge.
8) Straight vane #1 cracked at attachment to circular vane.

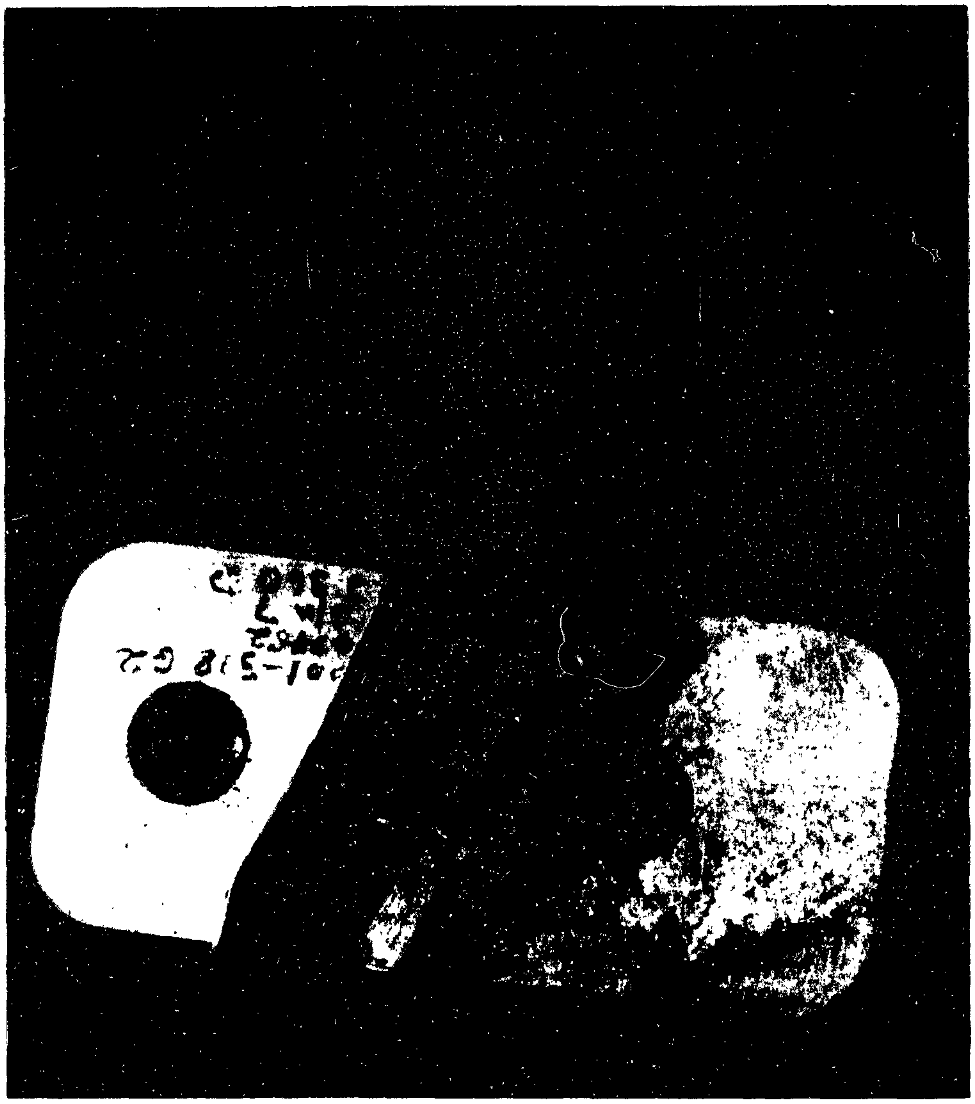


Figure 2. Circular Vane Mount Failure.

b) <u>Left Hand Aft Inboard</u>

1) Damping Lug (6 O'clock) worn.

c) <u>Left Hand Forward Outboard</u>

1) Circular vane trailing edge crack.

2) Straight vane #1 cracked at attachment to circular vane (both sides from leading edge to within 1" of trailing edge).

3) Straight vane #2 broken loose at attachment to circular vane. Impact damage due to hitting fan inlet door latch pin.

d) <u>Left Hand Aft Outboard</u>

1) Straight vane cracked on one side at circular vane attachment.

e) <u>Right Hand Inboard Forward</u>

1) Damping lug (12 O'clock mount) worn.

f) <u>Right Hand Outboard Aft</u>

1) Straight vane crack on aft side.

g) <u>Right Hand Outboard Forward</u>

1) Straight vane #1 crack at circular vane attachment on both sides.

Post failure microscopic analysis revealed that material in the left hand, forward inboard, 12 O'clock mount was not in T_6 condition. Rockwell tests showed average hardness less than T_4 condition.

X-Ray of all quadrants revealed no further cracks in addition to those already noted. Porosity and lack of penetration were evident in all welds, especially the trailing edge weld. This weld has been particularly troublesome throughout the manufacture and efforts to improve the integrity have met with little success. Manufacturing processing of the weld after X-ray, to improve the aerodynamic contour, had resulted in thin areas which could not be determined by later non-destructive inspection methods prior to acceptance of the vane. The successful completion of specified penalty runs during flightworthiness testing indicated that the welding and manufacturing processing of the vanes were satisfactory and the vanes were adequate to withstand the gas loads experienced during flight.

Detailed review of the damage and microscopic data in early June 1964 described above indicated that three failure areas were present:

1) Circular vane trailing edge crack.
2) Straight vane attachment to circular vane attachment cracks.
3) Possible low strength material at the vane mounts.

A review of the steady state stress analysis showed a maximum stress of 8800 psi on the circular vane convex side between the straight vane attachments (no failure).

It was concluded that the vane in its as-designed condition had manufacture and material deviations that resulted in cracks after short time loading in the higher cross flow fields. The loading (steady state or dynamic) could result in cracks that would propogate in the dynamic field. Accordingly, permission was received to modify two sets of inlet vanes (not previously run in cross flow) to remove the noted vane deficiencies. Modification I consisted of a row of bucked rivets along the circular vane trailing edge, the addition of welded brackets improving the straight vane attachment at the circular vane, and heat treat to get T_6 properties.

During the time the eight quadrants were being brought up to Modification I status, eight as-designed vanes from aircraft number 2 were reinstalled in aircraft number 1 for continuation of low speed tunnel testing. Strain gages were added to these quadrants in an attempt to get data on the level of dynamic loading in the previous failure areas. These gages were monitored and the data recorded on magnetic tape. Tests at 1700 RPM and up to 60 knots did not show any legitimate stress higher than 3000 psi double amplitude. These vanes were run in this mode for nearly 7-1/2 hours and except for a small circular vane trailing edge crack and one straight vane/circular vane crack which were repair welded, did not reveal any significant failure. The small cracks were noted after 2 hours and did not propogate after repair (additional 5-1/2 hours of test).

The Modification I vanes were installed and tested at 2300/2400 fan RPM to 60-80 knots for 1-1/2 hours without failure. However, after approximately 2 minutes at 2500 RPM and 100 knots, the tests were stopped and inspection revealed a series of spot weld cracks in the straight vanes and circular vanes where an internal channel section had been attached as part of the design to handle in-plane shear loads, and to help the airfoil maintain its section modulus. These cracks were regarded as another incidence of stress concentration failure in the welded portion of the vane. It was significant to note that after tests at higher loads and time than before, the original failures were not realized. The same eight quadrants were changed to Modification II status by the addition of a 0.030" 61ST6 aluminum doubler placed circumferentially over the spot weld joints. The doubler was attached to epoxy resin and cherry rivets.

Tests were resumed. Inspection after 41 minutes, 2400 RPM and 60 knots showed no damage. Inspection after 10 minutes, 2500 RPM, 100 knots showed no damage. Inspection after 30 minutes, 2500 RPM, and 100 knots showed cracks in the straight vane that has the bent leg for dome attachment. These cracks occurred in two quadrants and were in the weld at the vane leading edge. No additional tests were performed due to shutdown for tunnel repair. Further inspection of the vanes showed no recurrence of original failures, and no further evidence of spot weld cracks. It was concluded at this time that the existing vane design (as modified), material, and fabrication did not have sufficient capacity for sustained high speed, high cross flow loading. Continued modification would extend the part life for a frequent inspection 50 hour flight test program, but follow-on 100 hour test programs would require a design utilizing materials and processes that had sufficient capacity for the dynamic loading in transition flight modes.

The vane operation performance in the wind tunnel was analyzed to establish a safe flight test limit (Figure 3). All the combinations of fan speed and tunnel velocity were analytically reduced to a per cent of design load basis and plotted against time of no failure operation (Figure 4). It was concluded that the aircraft could fly to 60 knots in the VTOL mode without the incidence of vane failure.

INLET VANE HISTORY

Aircraft Number 1, Fans 005 and 006

Ryan	1.06 hrs.	Ground	100% J85
Ames	3.20 hrs.	Ramp	100% J85
Ames	3.16 hrs.	40 x 80	1700 RPM - 60K
	40 min.	40 x 80	2400 RPM - 40K
	34 min.	40 x 80	2400 RPM - 60K
	6 min.	40 x 80	2400 RPM - 60K
	34 min.	40 x 80	2400 RPM - 80K
	Failure		

Install Vanes - Aircraft Number 2

5.16 hrs.	Ryan + EAFB	100% J85
3.75 hrs.	40 x 80	1700 RPM - 30-40K
2.00 hrs.	40 x 80	1700 RPM - 60-70K
1.90 hrs.	40 x 80	1700 RPM - 40-60K

Install Modification I

1.55 hrs.	40 x 80	2300-2400 RPM - 60-80K
2 min.	40 x 80	2400 - 100K
Spot Weld Crack		

Install Modification II

41"	40 x 80	2400 RPM - 60K
10"	40 x 80	2400 RPM - 100K
Fairing Failure - Rotor Damage		
30"	40 x 80	2400 RPM - 100K
Bent Vane Weld Crack		
59"	40 x 80	1700 RPM - 40K

FIGURE 3

No. Failure Test Points

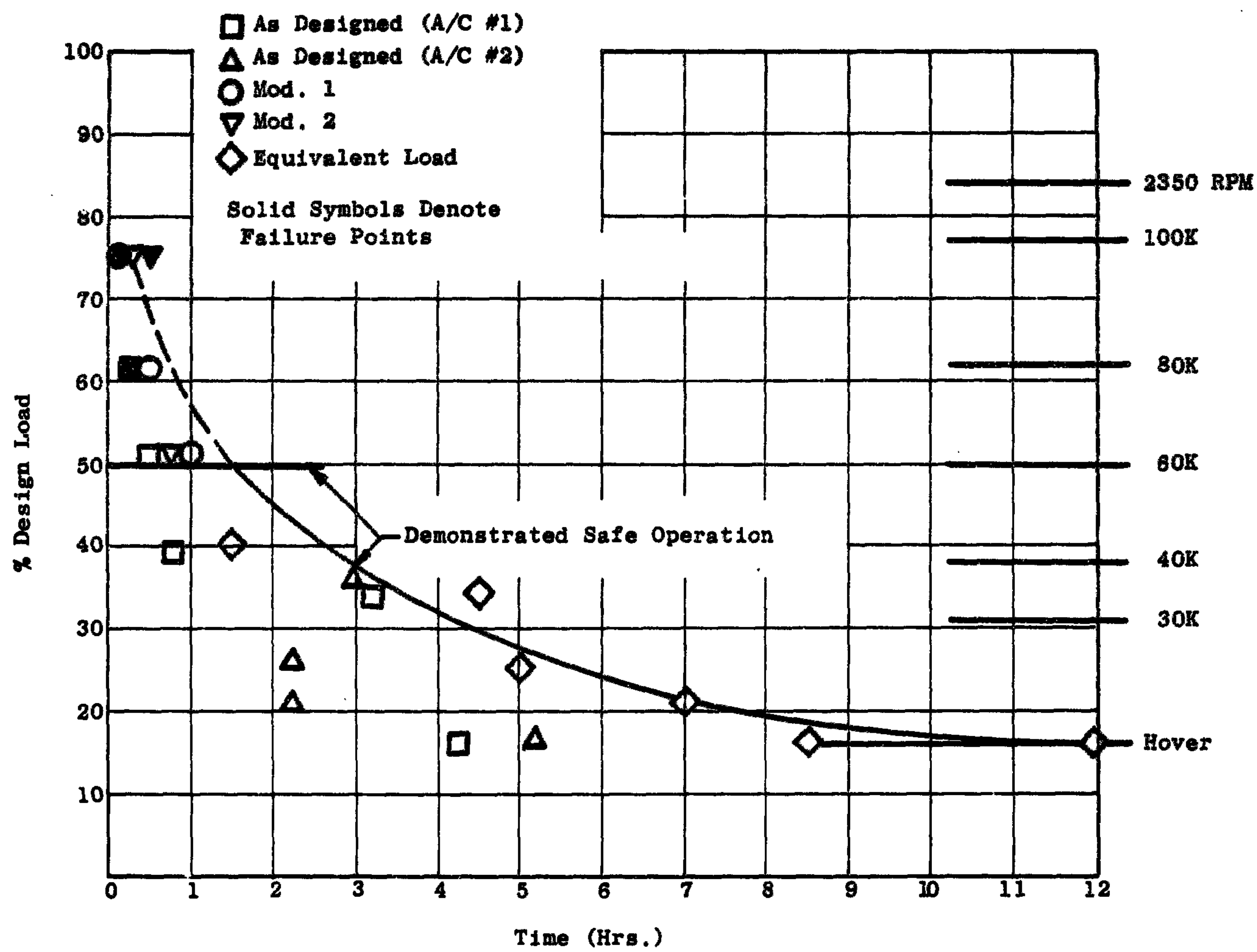


Figure 4. Safe Operational Limit - Inlet Vanes.

There was no attempt during the tunnel test program to conduct sustained continuous loading for significant times. Consequently, the load-life analysis is not a measure of maximum vane capacity as the data are based on conditions accumulated as a result of the wind tunnel test schedule. It can be noted that the only significant time accumulation occurred on the original, as-designed vanes, and the improvements realized as a result of Modifications I and II changes are used only as a safety factor to assure a safe flight test program with the 60 knots flight speed limit.

A steel vane design was completed and reviewed for the XV-5A program requirements (long range 100 hour program, and short range 50 hour program). Manufacturing estimates of 12 weeks for the first set delivery (4 quadrants) resulted in a decision to go ahead, but prompted immediate review and go ahead on a Modification II aluminum vane redesign to provide assurance of a continuing flight test program until steel vane availability.

Inlet vane Modification III is a continuation of efforts to remove or reduce the effects of weld fabrication stress concentrations in the assembly. The vane quadrants selected for this modification are new-unused pieces of hardware; hence, there has been an opportunity to improve the basic Modification II design as well as initiate Modification III. The Modification II improvements are simply more quality control, uniformity, wider spot weld reinforcement doublers, beveled edges on welded reinforcement pads (straight vane/circular vane) to optimize weldability. In Modification III, the fix has been extended into the areas of the mounting pads, more efficient joint design at the straight vane/circular vane, backup of welded areas at mounts with rivets, and reinforcements to improve the in-plane shear load distribution into the mounts. The most significant change in the Modification III vane occurred as a result of extended steady state stress analysis. The 3 O'clock mount has been changed from a fixed to a pinned (uniball) mount. Stress analysis data indicates a significant drop in steady state loading as a result of this change. This is best explained by a quick review of the vane design. The vane quadrant principal loads occur as a result of (1) air loading of the vanes, and (2) axial deflection of the front frame bellmouth. The fan mounting arrangement

permits the outboard end of the minor strut to rotate about the major strut axis as a result of bellmouth aerodynamic loading and rotor gyro maneuver loading. The inlet vane original design included a pin at the 12 O'clock and 6 O'clock positions to eliminate high bending loads induced as a result of the frame deflection. The 3 O'clock and 9 O'clock mounts were rigidly bolted to the minor struts.

Modification III and the steel vane designs both use the pinned (3 direction) mount. The reduced steady loads and resultant higher dynamic capacity should result in a significant increase in inlet vane life and mechanical integrity.

Modification III drawings have been prepared; and manufacturing reviews resulted in scheduled four (4) week delivery. Vane manufacture is in process.

Current flight test speed limits are the result of demonstration in very accurate load conditions. Modification III will be evaluated by a bench vibration test at General Electric, Evendale.

B. STABILITY AND CONTROL

1. Progress

The major effort during this reporting period was applied toward preparation for and analysis of results from the XV-5A full scale wind tunnel tests conducted at the Ames 40' x 80' wind tunnel during the period from May 17 to June 18, 1964.

Some of the principal findings of the test program are illustrated in Figures 5 through 8. Trimmed values of thrust coefficient and lift coefficients are shown in Figure 5 for zero drag and zero pitching moment for the range of exit louver vector angle. Longitudinal stick positions are shown for pitching moment trim for the center of gravity range from Station 240 to 246. The same information is given in Figure 6 for the forward c.g. location as affected by horizontal tail incidence. These results show the importance of using large tail incidence angles to maximize the control margin at intermediate speeds in transition, but tail incidence settings must be weighed against the possibility of tail stall as discussed below.

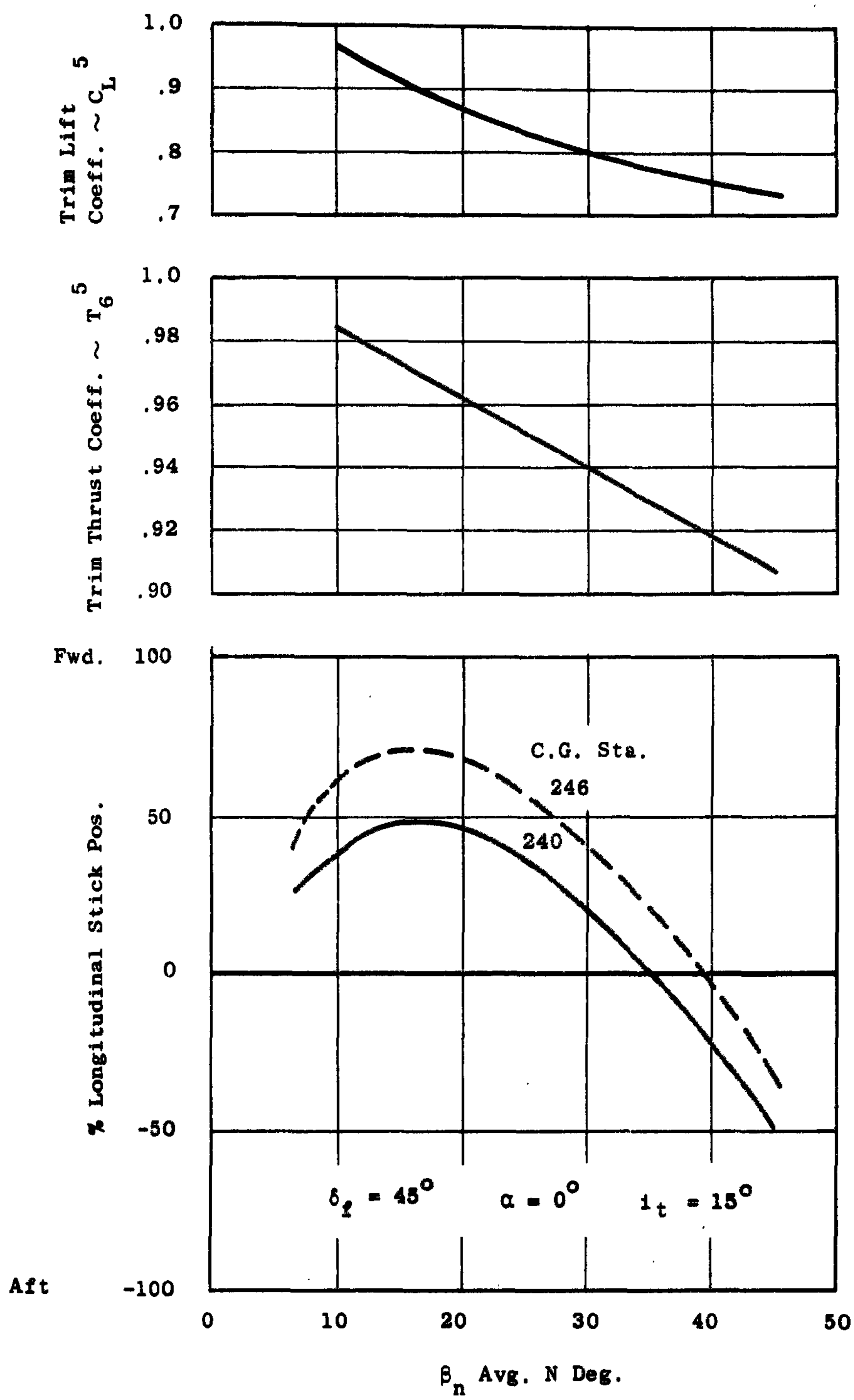


Figure 5. XV-5A Effect of C.G. Location on Longitudinal Trim.

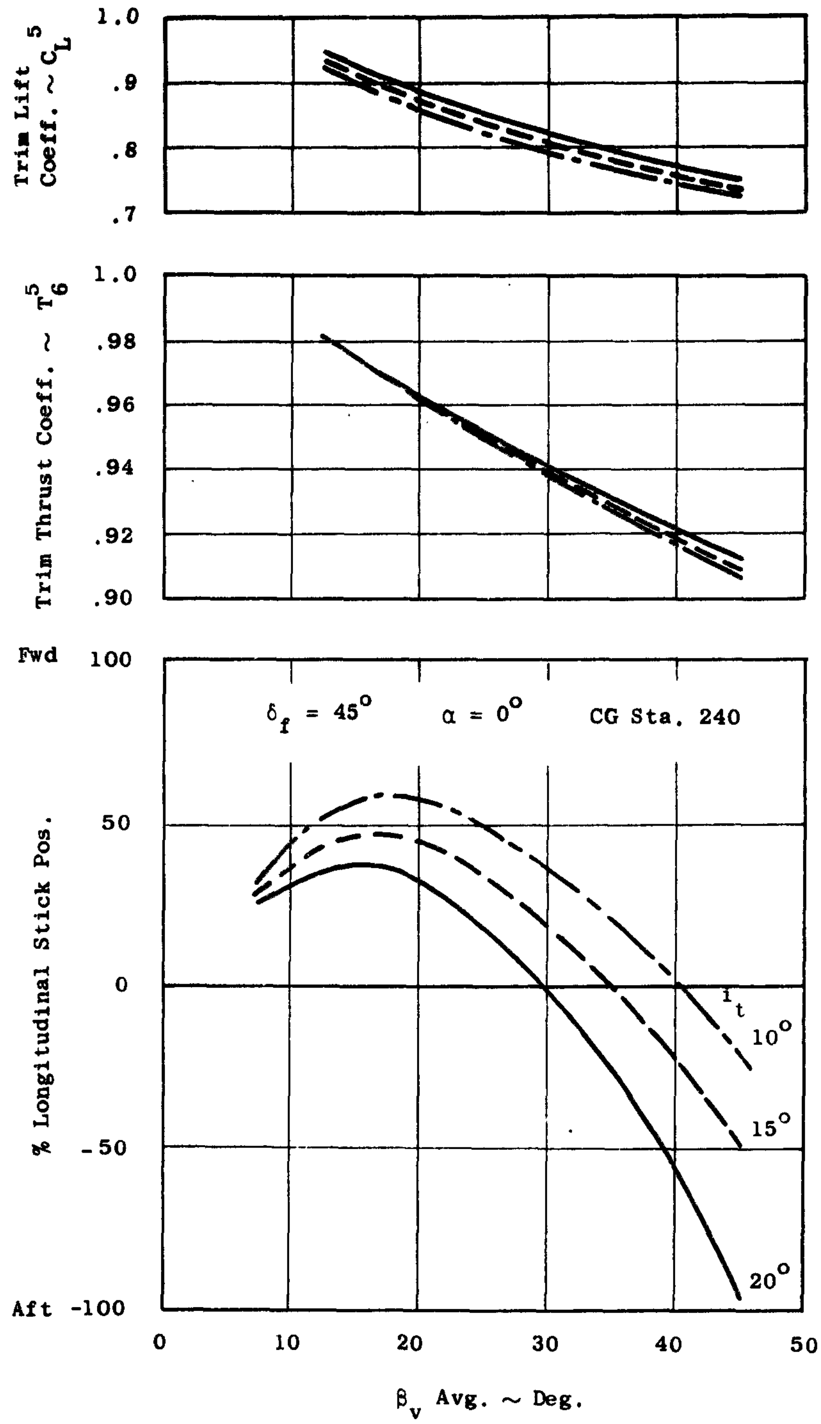


Figure 6. XV-5A Effect of Horizontal Tail Incidence on Longitudinal Characteristics.

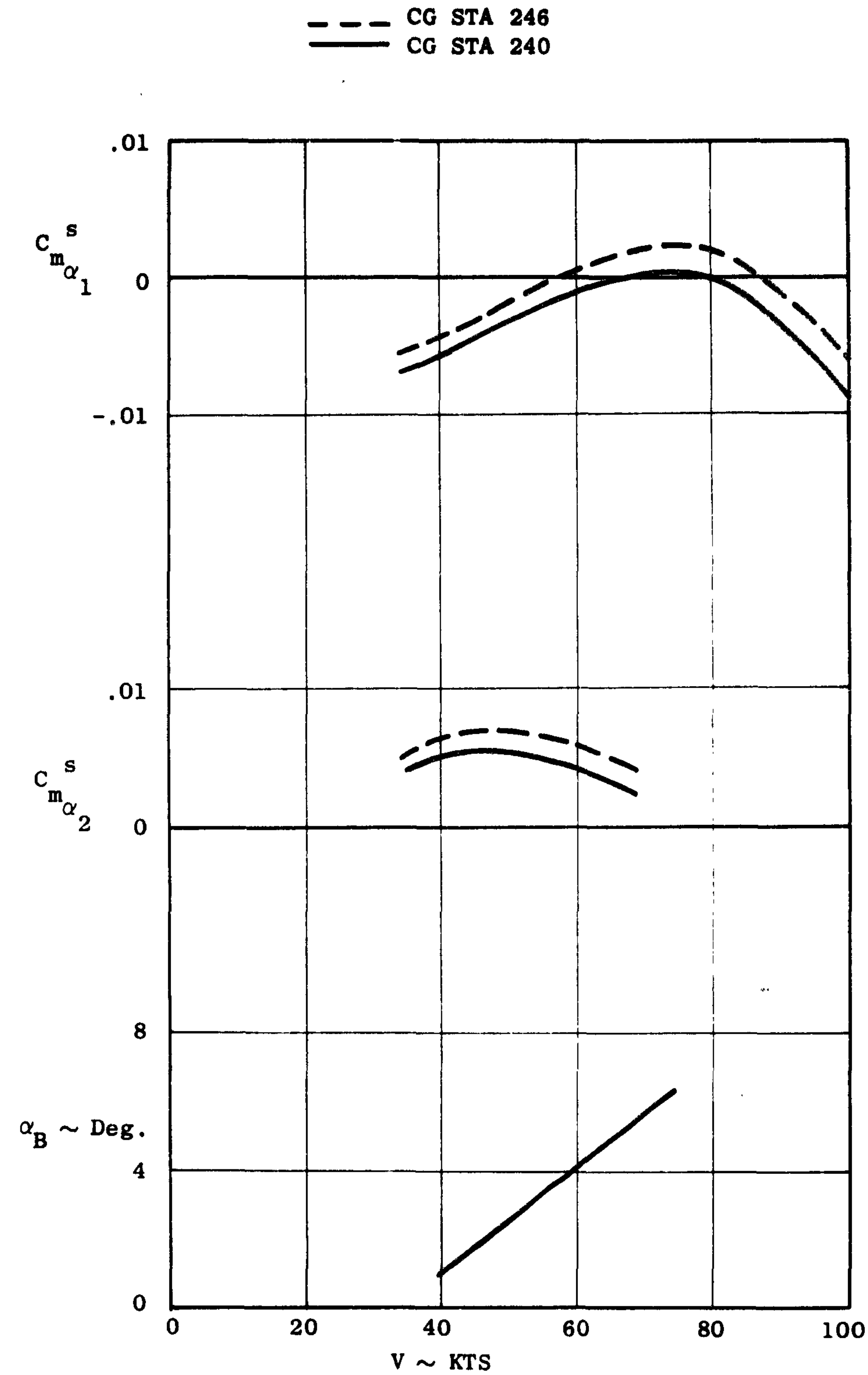


Figure 7. XV-5A Longitudinal Stability Characteristics - Effect of CG Location - Fan RPM ~ = 2300.

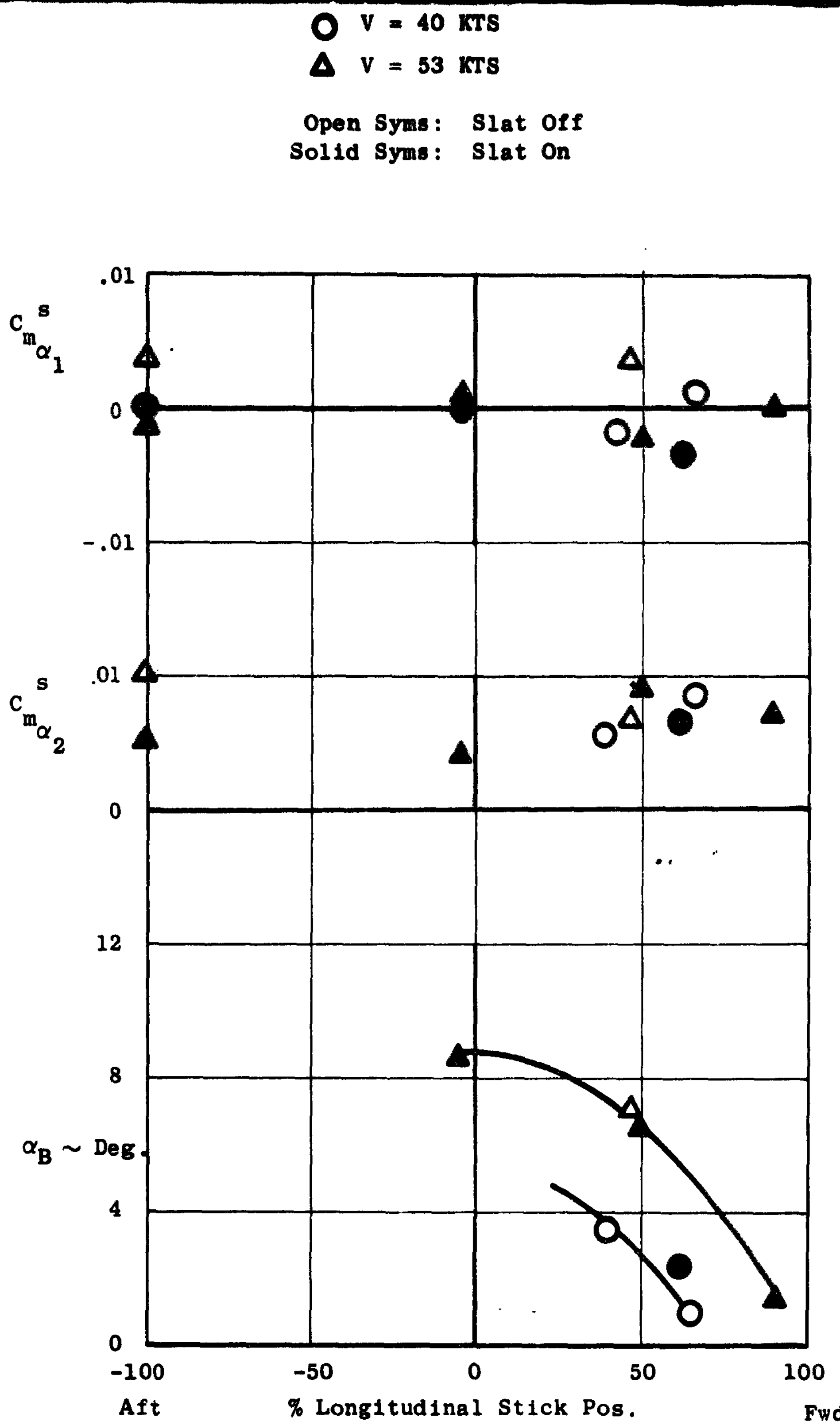


Figure 8. XV-5A Longitudinal Stability Characteristics - Effect of Stick Position and Tail Slat.

Longitudinal stability characteristics are shown in Figures 7 and 8. Stability is affected by flight speed (and associated vector angle), c.g. location, longitudinal stick position, and horizontal tail incidence. In the figures, $C_{m_\alpha}{}^s$ is defined as the slope of the pitching moment curve through zero angle of attack, $C_{m_{\alpha_2}}{}^s$ the slope following a clearly defined break in the pitching moment curve in the unstable direction, and α_β the angle at which the break occurs. In Figure 8 a predominant effect of longitudinal stick position, which governs nose fan thrust reverser low position, is shown on α_β with little effect on the stability level. It was also observed that even with the nose fan inoperative, the break in the pitching moment curve occurred when the horizontal tail was at maximum incidence angle, indicative of tail stall.

Addition of a leading edge slat to the horizontal tail during the tunnel test did not provide the delay of tail stall expected, but did improve the stability level and indicated that along with the use of lower incidence angles a larger stall margin could be obtained. An improved slat design was made for installation on the XV-5A for the initial low-speed transition flight tests, see Figure 9.

Revisions were made to the wing fan exit control mixer and to the extreme stop positions of the cockpit collective control to obtain an increase in roll control power for the original exit louver system. A 35 per cent increase in roll power was estimated to result from the change at nominal collective control position ($\beta_s = 27°$).

A summary of the revisions is given below:

	Control Command $\beta_V = 0$	Original Configuration	Revised Configuration	Principal Reason For Change
a)	Collective at max. lift stick centered.	$\beta_s = 13°$	$\beta_s = 15.5°$	At max. collective retain greater roll power and reduce yawing moment due to roll command.
b)	Collective at min. lift stick centered.	$\beta_s = 37°$	$\beta_s = 35°$	At min. collective retain greater roll power and reduce yawing moment due to roll command.

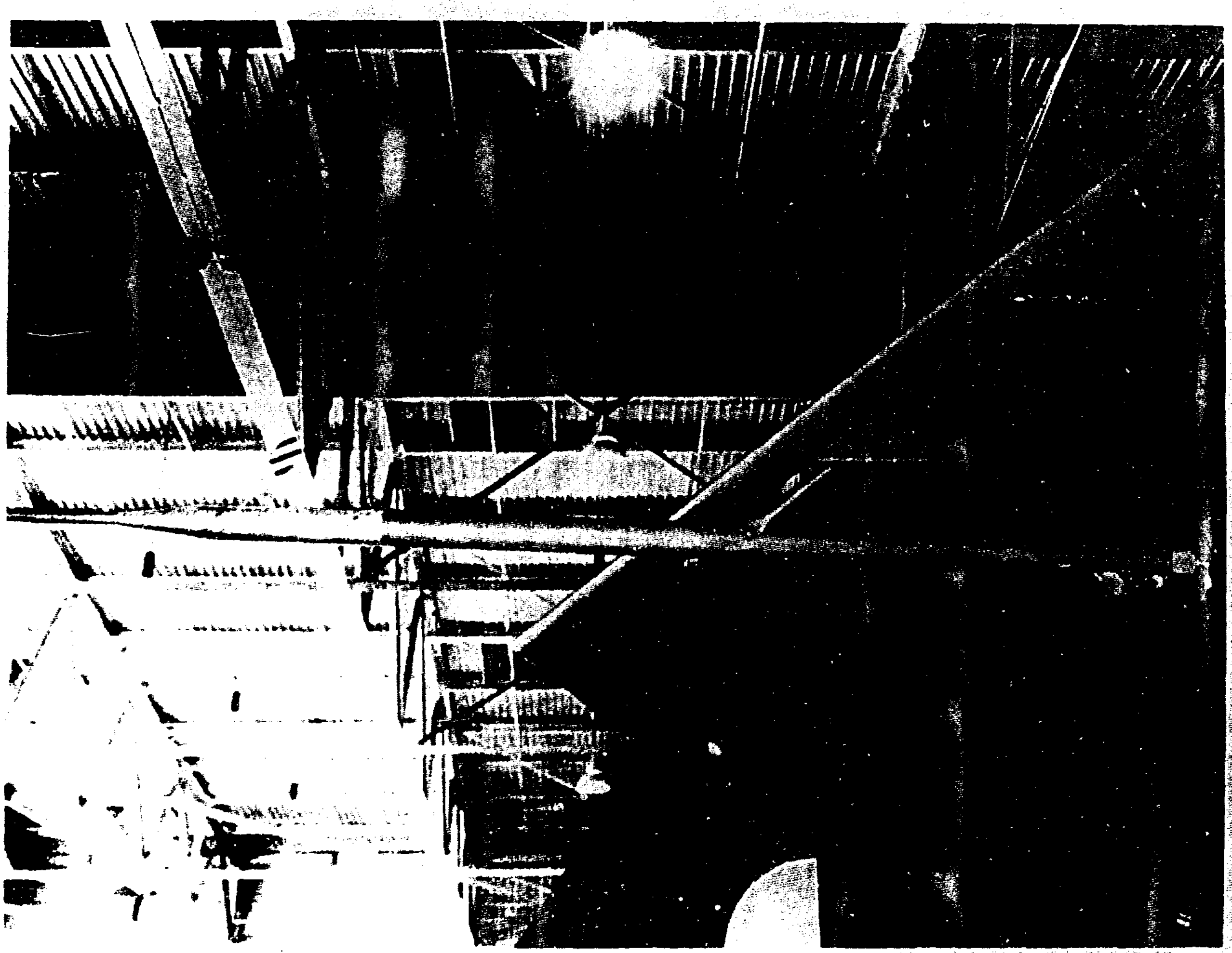


Figure 9. Horizontal Tail slot and Instrumentation Boom.

The following collective settings refer to original values:

Control Command $\beta_v = 0$	Original Configuration	Revised Configuration	Principal Reason For Change
c) Full right stick collective at max. lift.	$\beta_{s_L} = 0°$, $\beta_{s_R} = 29.5°$	$\beta_{s_L} = 0°$, $\beta_{s_R} = 33.5°$	Increase roll control power
d) Full right stick collective at nom. lift	$\beta_{s_L} = 12°$, $\beta_{s_R} = 37°$	$\beta_{s_L} = 7°$, $\beta_{s_R} = 40°$	Increase roll control power.
e) Full right stick collective at min. lift.	$\beta_{s_L} = 22.5°$, $\beta_{s_R} = 40°$	$\beta_{s_L} = 19$, $\beta_{s_R} = 40°$	Increase roll control power.

Ground tests to determine the actual control powers available in the aircraft after the control system modifications were evaluated during May and June at NASA-Ames. In addition to the tests involving the actual stagger authority change, the effect of clamping the louvers at their trailing edges to reduce louver deflection was also obtained. A large gain in stagger effectiveness was shown by the restrained louver tests. A stiffened louver system was provided by General Electric for subsequent ground test of Aircraft Number 2, on the USAF VTOL test stand at Edwards Air Force Base. Roll control powers in excess of 2.5 rad/sec^2 capability were demonstrated over a range of collective control positions with the reworked louvers and the modified wing fan control system mixer configuration previously tested at NASA-Ames, see Figure 10.

The first and all subsequent hovering flights of the XV-5A were conducted with the control system configured as tested for the previous VTOL test stand tests at Edwards Air Force Base.

An analytical study was conducted to determine the lateral static stability of the aircraft on the ground at power levels less than that required to achieve hovering lift-off. The analysis indicated that high destabilizing moments occur at high power levels if single main gear contact is obtained. The study indicated that devices for the purpose of either stabilizing the aircraft or to provide

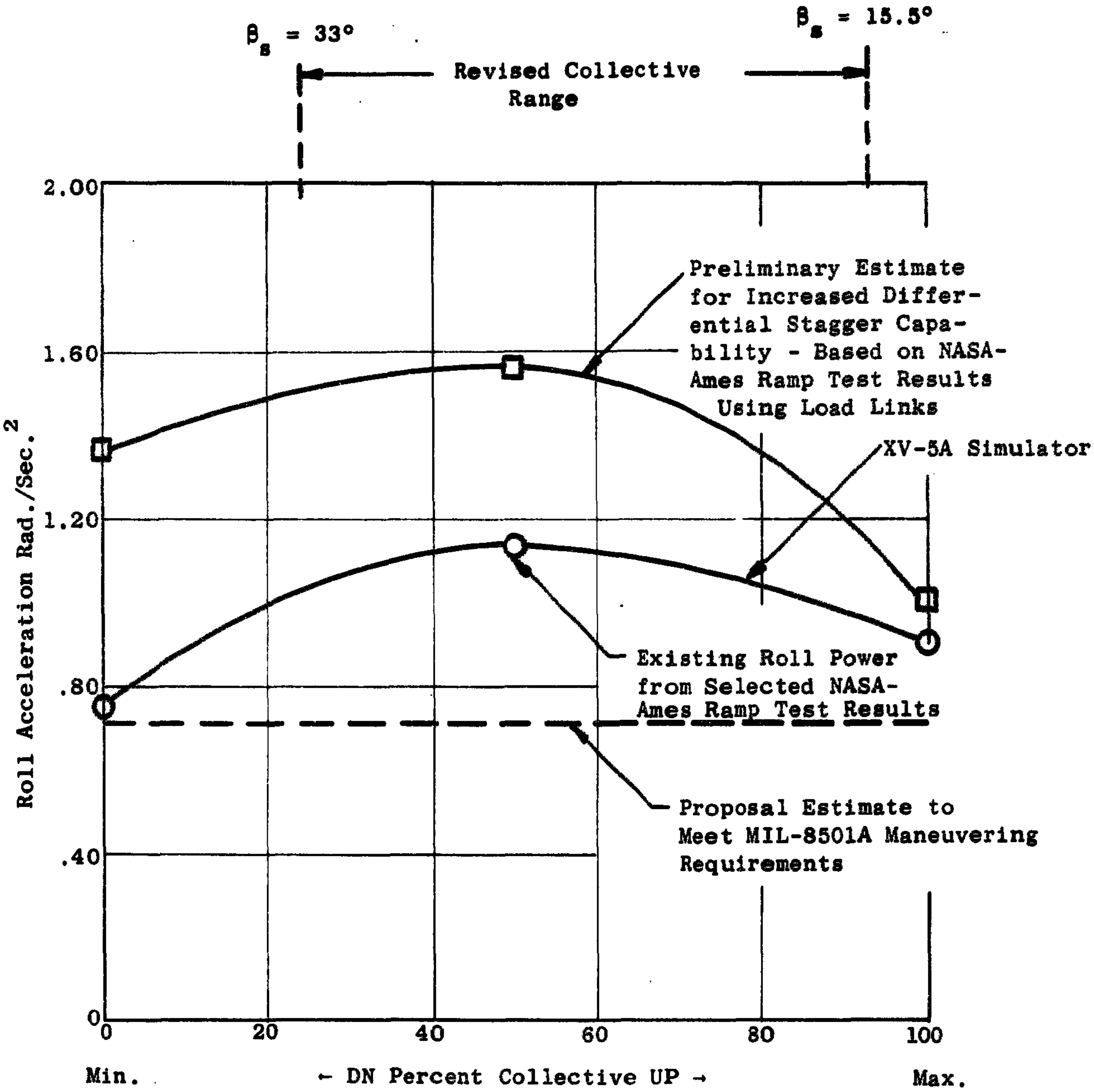


Figure 10. XV-5A Roll Control Power Summary.
$\beta_V = 0$.

roll-over protection might be required; however, it was felt that the area of concern could be safely investigated by cautious test of the actual aircraft. A preliminary design study for a ground stabilizing outrigger landing gear system to satisfactorily stabilize the aircraft has been completed.

Results of the stability analysis are summarized in Figures 11, 12 and 13. The Estimated Dynamic Stability Report, Ryan Report 64B104, was completed and issued this quarter.

2. Schedule

The stability and control efforts were on schedule, with the exception of the Predicted Flying Qualities Report.

3. Plans for Continuing

a) Continue analysis of full-scale wind tunnel data.
b) Complete preparation of Predicted Flying Qualities Report.
c) Support of Flight Test Program.

C. CONTROL SYSTEM ANALYSIS AND SIMULATION

1. Progress

a) Elevator-Nose Door Feedback

A possible problem area due to elevator-nose door feedback at high fan-powered flight speeds was investigated.

Due to the flexibility of the longitudinal control stick support structure, the stick-fixed elevator natural frequency was measured to be about 9 cps. As this frequency was very close to several symmetric body bending modes, and stick base deflections fed directly into the nose-door push-rod system, it was felt necessary to investigate possible coupling into the flexible body modes.

The stick-fixed equations of motion including the first two symmetric body modes were developed, and the system was evaluated on the analog computer. It was found that twenty times the present level of elevator to nose-door coupling could be tolerated before sustained oscillations could be set up.

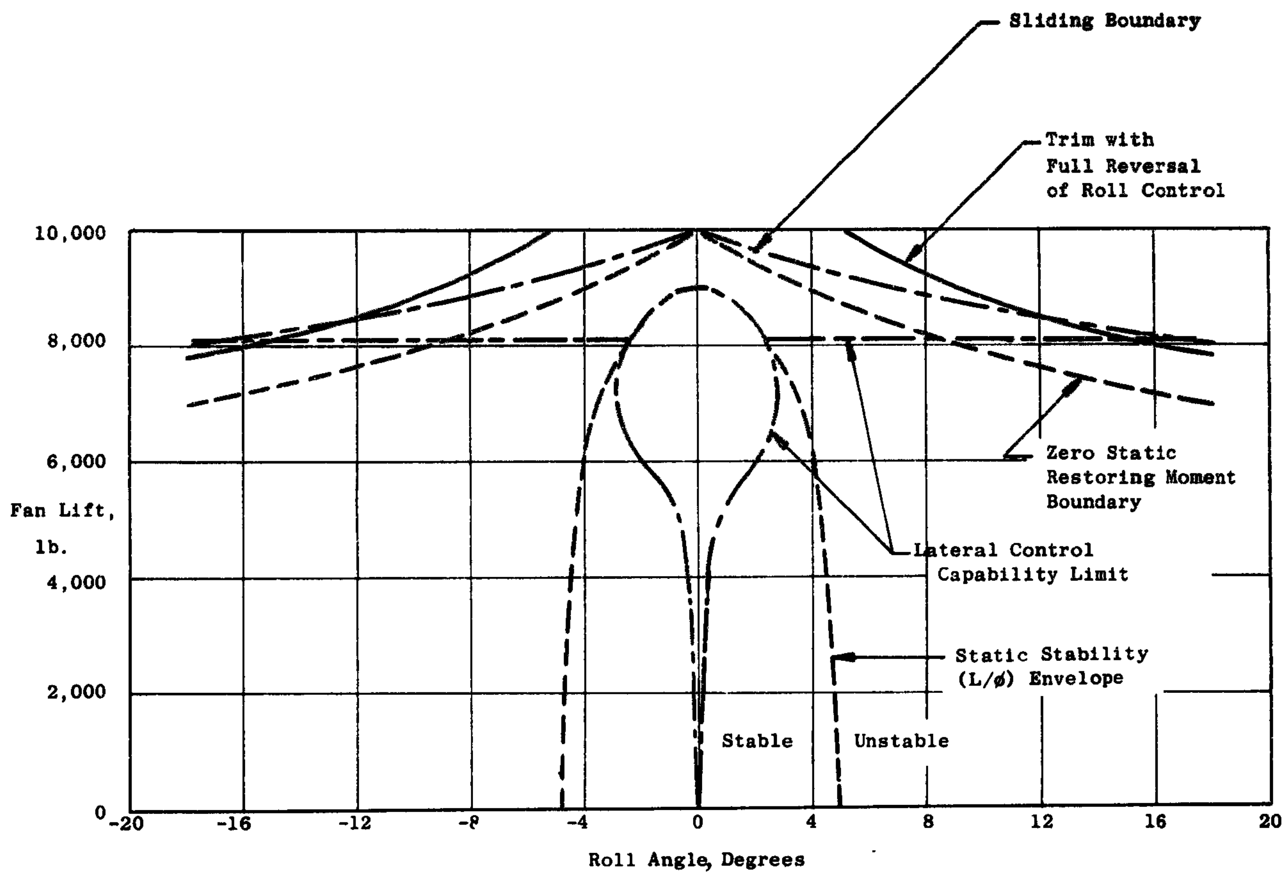


Figure 11. Roll Attitude Stability and Control Power with Gear Reactions. W = 10,000 Lb.

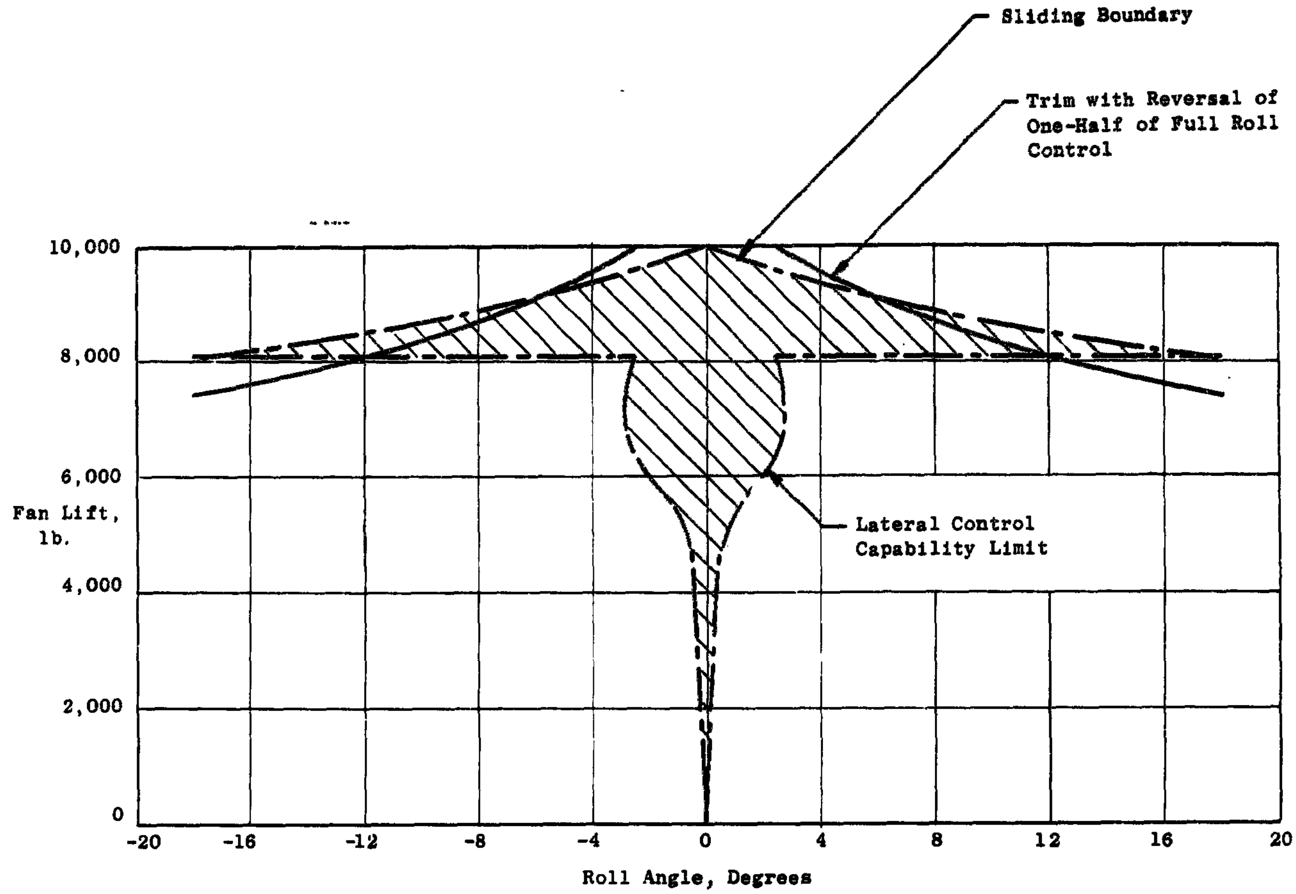


Figure 12. Roll Control Capability Envelope with Gear Reactions. W = 10,000 Lb.

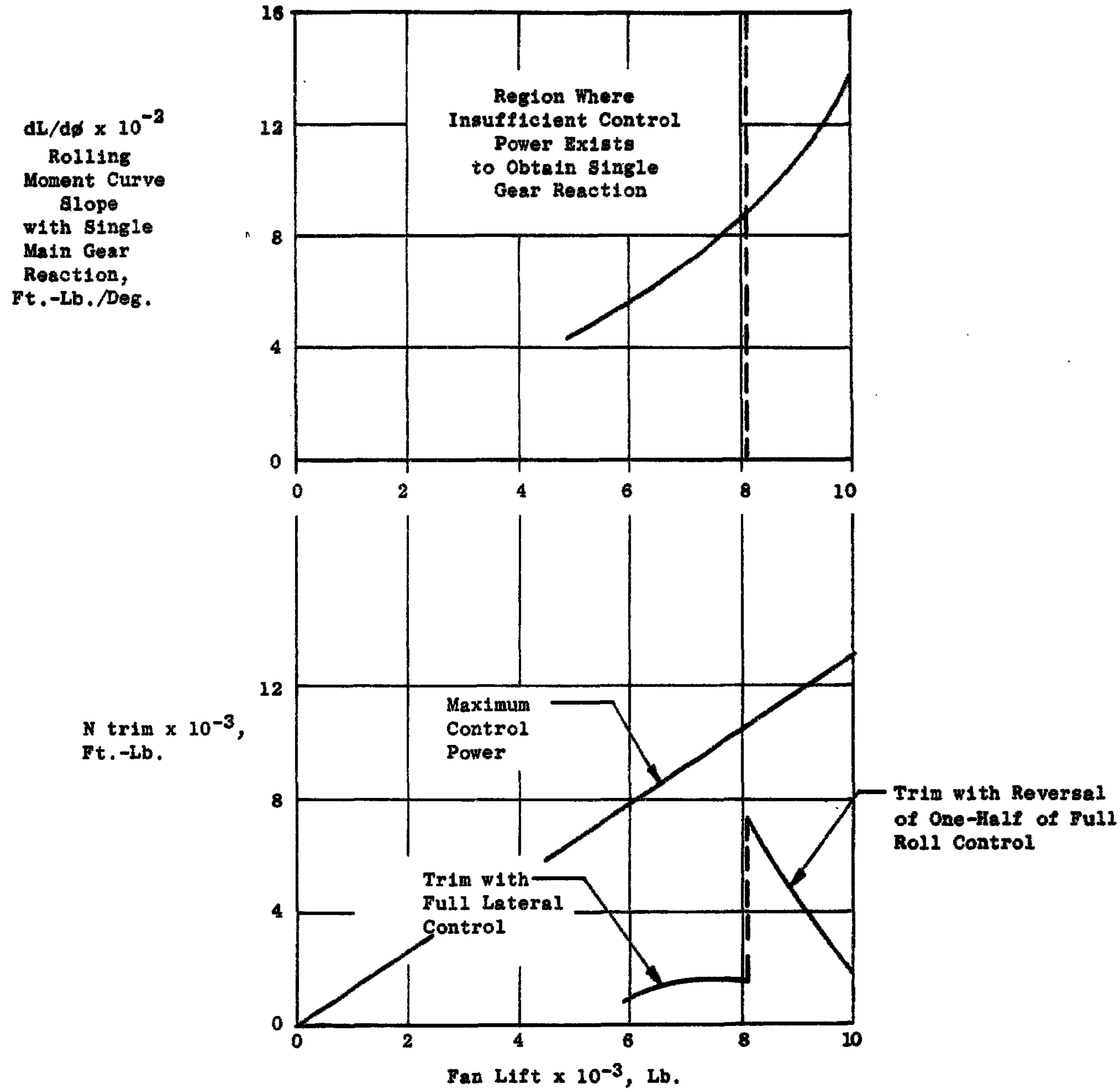


Figure 13. Level of Rolling Moment Instability and Yawing Moment Required for Trim. W = 10,000 Lb.

b) **Stability Augmentation System Changes**

Frequency response runs on the aircraft louver system while operating tied down in the fan mode showed that the response of the louver servos is degraded as a result of the louver air loads.

The old louver servos had first-order time constant of .05 seconds, while the new servos under the existing louver air loads exhibit a time constant of approximately .1 second.

It has been determined from thrust stand tests that the rolling moment due to differential stagger curve has considerably more variation in slope than the data used for the simulation. This slope varies widely with collective lift stick setting.

The combination of louver servo response under air load and increased rolling moment due to differential stagger at low lift settings resulted in a 1.5 cps limit-cycle roll oscillation during a portion of one of the hovering evaluation flights.

Root locus plots were made using the latest servo response data, and the system was examined to determine if there were any phase lags which could be removed to improve the system stability.

It was noted that the 15 cps notch network increased the lag at 1.5 cps enough to cause the oscillation, which occurred when the increased rolling moment due to stagger was included. Further, the method of discharging the holding capacitor in the maneuver mode further increased the system phase lag at 1.5 cps. These lags were removed by removing the notch in the roll system, and changing the holding capacitor discharge resistor from 470Ω to 47Ω.

The elimination of the notch network in the roll channel presented no difficulty, because it was originally included only to make all stability augmentation amplifier modules interchangeable, and with the original servo response caused no problems.

A verification of the high rolling moment due to stagger was obtained on Flight 14F when a 2.5 cps roll limit cycle appeared during a "double nominal gain" stability augmentation test.

c) Roll System Mixer Changes

The mechanical mixer box was modified during the last quarter to provide increased roll power and decreased coupling for combination roll and yaw inputs.

During most of the hover flights, an intermittent 1 cps oscillation was observed, occurring with nearly the same frequency, whichever pilot happened to be flying. At first this oscillation was thought to be from the stability augmentation system, but root locus plots predicted a higher frequency instability.

When the new stagger effectiveness became available after the thrust stand runs, calculations showed that the lateral control stick sensitivity was excessively high for a lift setting of nominal or less. At nominal collective stagger at 1" lateral stick movement from neutral resulted in .62 rad/sec^2 rolling acceleration. This value is well outside the acceptable region plotted in NASA TN-D-58.

The mixer box was returned to the original configuration, retaining the present $\pm$ 4" lateral stick throw. Further, the collective stagger at full lift has been limited to 17°. These modifications result in a variation of stick sensitivity from .15 rad/sec^2 to .72 rad/sec^2 rolling acceleration for the first inch of lateral stick travel, over the range of lift stick adjustment.

Further tests will be made increasing the lateral stick throw to $\pm$ 5", which will bring the stick sensitivity even closer to the .2 rad/sec^2/inch to .5 rad/sec^2/inch acceptable region of NASA TN-D-58.

The limitation of collective stagger variation due to the lift stick also serves to limit the variation of roll stability augmentation system gain, which is dependent upon stagger effectiveness for its operation. The present lift control limits result in a 4:1 variation of stability augmentation system gain, which provides acceptable flying qualities throughout the hover envelope, using the present "nominal" gain setting.

2. Schedule

The control system analysis and simulation is on schedule, except for the final Simulation Report, which will be issued early next quarter.

3. Plans for Continuing

Completion of the Final Simulation Report and support of flight test will encompass activities for next quarter.

D. STRUCTURAL ANALYSIS

1. Progress

a) Stress Analysis

During this reporting period the Stress Group has continued liaison in support of ground and flight test efforts. Some of the specific tasks accomplished have included:

1) A study of the General Electric wing fan structural components (louvers, louver actuating push rods and linkage, forward strut actuator fittings and inlet guide vanes) with recommendations for improving structural integrity in view of the new higher force actuators.
2) A study of the failure during wind tunnel testing of the cooling ejector duct portion of the upper wing fairing assembly. This study resulted in a modification of the fairing and in the methods of attachment of the fairing to the wing fan structure.
3) A study of the allowable drop heights and allowable sink rates of the XV-5A aircraft assuming the loss of one engine power to the fans. This study, based on the allowable landing gear loads, included aircraft c.g. positions from Sta. 234.0 to 246.0, aircraft gross weights from 9000 to 12,000 pounds, main landing gear in both CTOL and VTOL positions and aircraft velocities from zero to 100K.

Results of this study indicate that the original design allowable sink rate of 10 fps, M.L.G. in the aft (VTOL) position, and an aircraft gross weight of 9200 pounds with c.g. at Sta. 240.0, is reduced to approximately 8.5 fps under the resulting loss of lift condition. The allowable sink rate is further reduced with an increase in gross weight or movement of the c.g. forward of Sta. 240.0. Figures 14 and 15 show allowable sink rates at zero and 100K conditions. Figure 16 shows allowable single engine out altitude during hover. The height allowable with the gear in the CTOL position is shown in Figure 17.

b) Weight Control

The weight control effort has continued at Edwards Air Force Base, however, ever increasing instrumentation requirements have resulted in increased "fly away" weights. In addition, aircraft changes required from ground and flight tests have resulted in weight increases. As flight testing events are completed, specific instrumentation items will be deleted, resulting in weight reduction. One such item planned for removal soon is the photo panel recording unit, which will reduce the payload weight by approximately 100 lbs.

Table I summarizes the weight change as of July 15, 1964, compared with original target weights. The net result results in approximately 1000 lbs. of fuel available during recent hover flights at Edwards Air Force Base, with a lift to weight ratio of 1.15. The last actual weight measured at Edwards Air Force Base, minus pilot and usable fuel, was 8713 lbs. Included in this weight were such items as unusable fuel and oil, main landing gear wheel well temporary steel fairing, the auxiliary dorsal fuel tank, and approximately 600 lbs. of instrumentation.

Delection of the weight of the above items and other equipment not included in the Contractual Weight Empty gives a revised Weight Empty of 7992 lbs. At the start of ground test the Weight Empty was 7541 (ref. Calculated Weight Report No. 63B123). This increase of 451 lbs. is due to many small improvements plus large weight items such as nose landing gear beef-up, main landing gear insulation from fan heat, increased power for fan louver control, pitch fan thrust

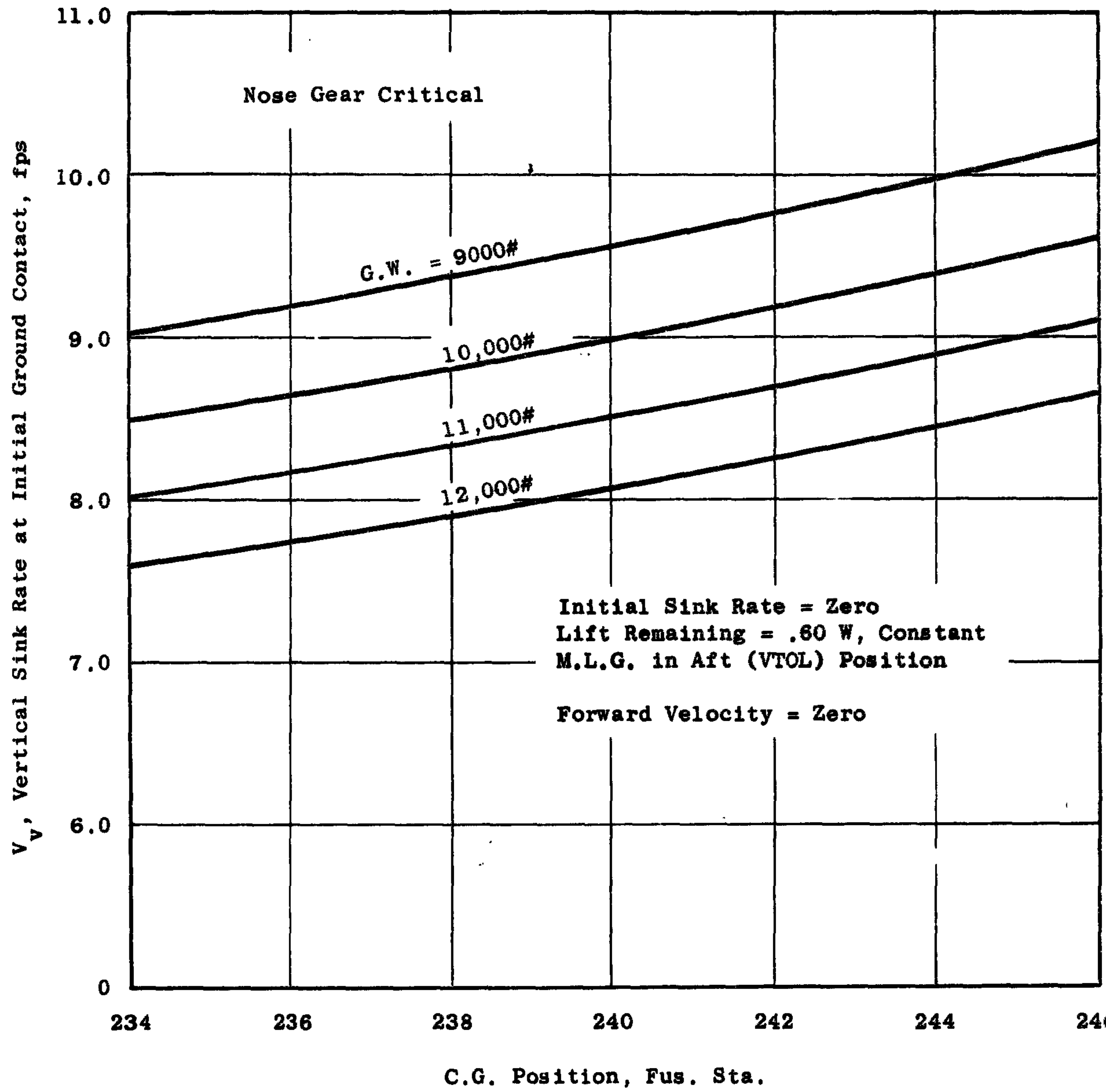


Figure 14. XV-5A Allowable Sink Rate Assuming Loss of One Engine.

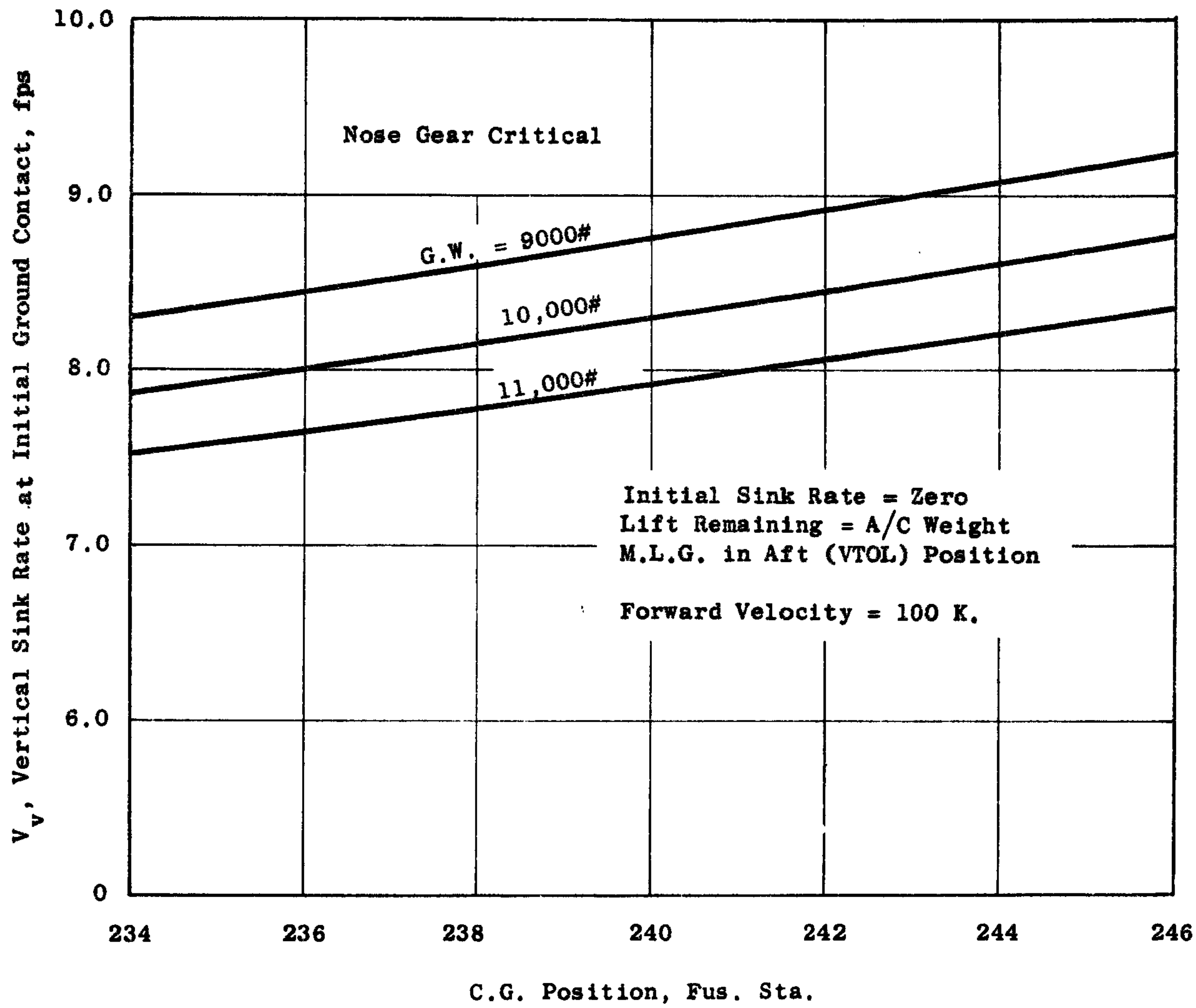


Figure 15. XV-5A Allowable Sink Rate Assuming Loss of One Engine.

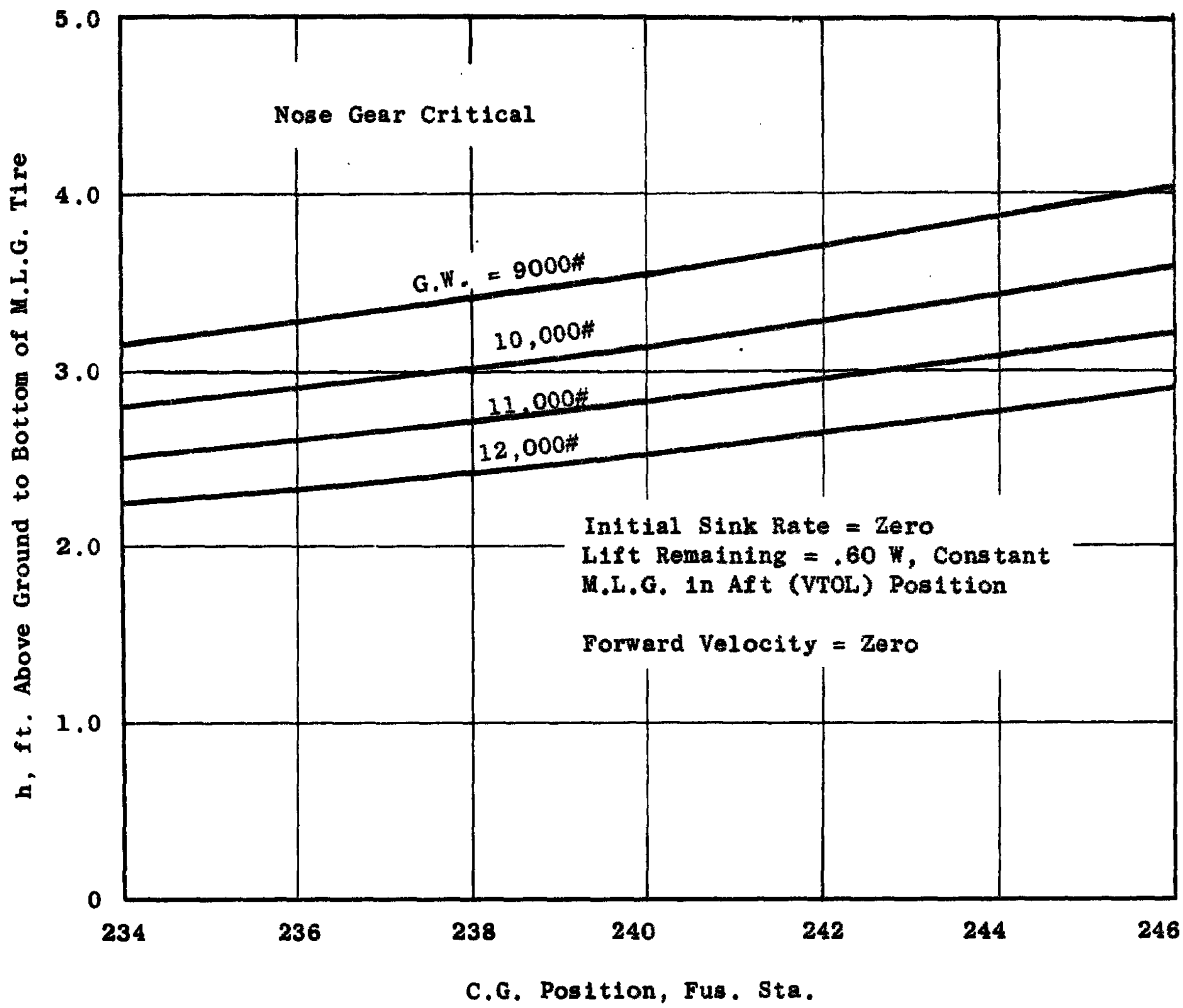


Figure 16. XV-5A Allowable Hover Height Assuming Loss of One Engine.

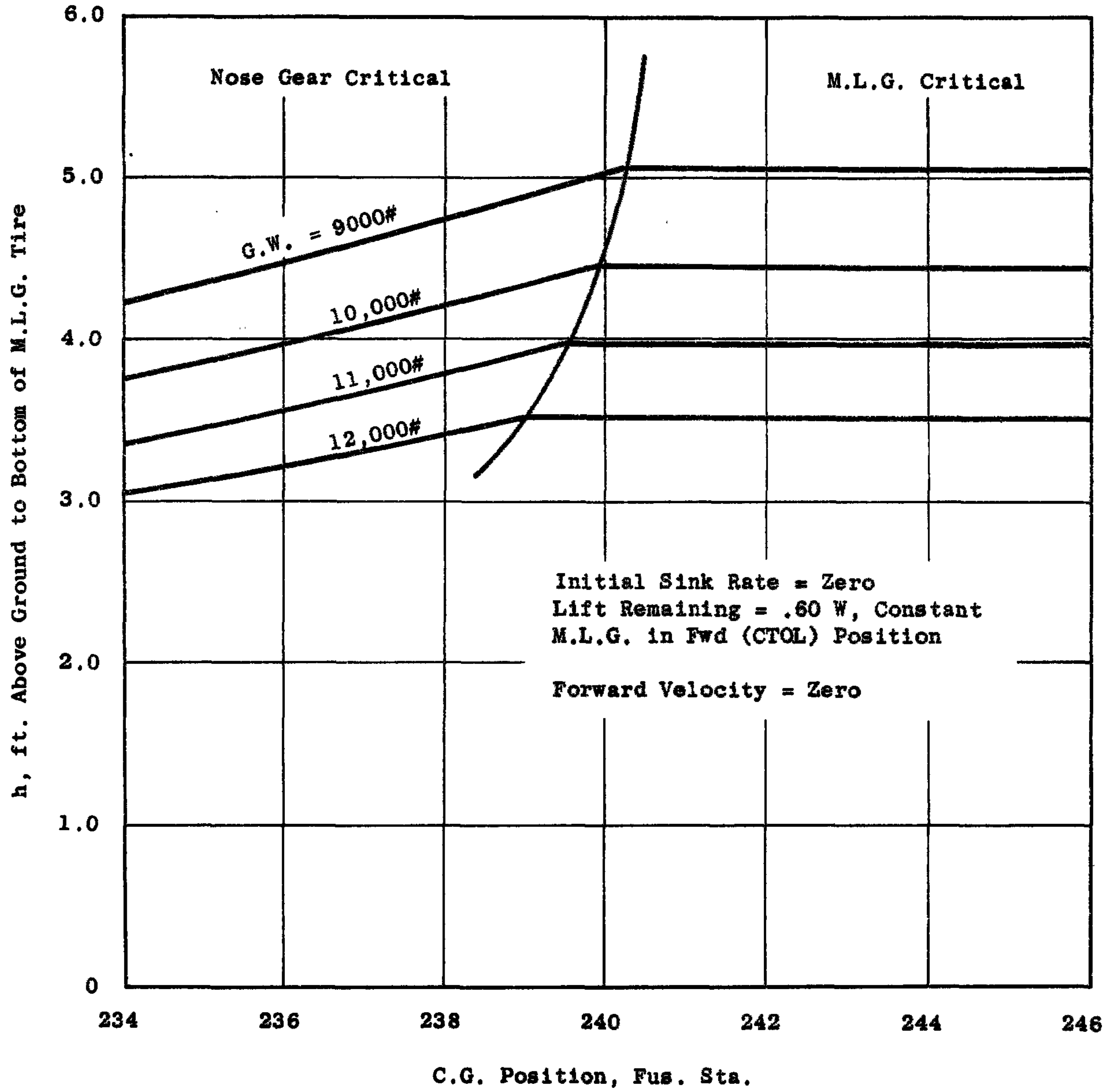


Figure 17. XV-5A Allowable Hover Height Assuming Loss of One Engine.

TABLE I

WEIGHT CHANGE SUMMARY

(Status as of 8/15/64)

Design Group	10/31/63 Status	8/15/64 Status	Change
Forward Fuselage	695.67	713.37	17.70
Controls	131.31	139.10	7.79
Electrical	331.03	339.13	8.10
Landing Gear	422.15	481.61	59.46
Hydraulics	308.86	365.36	56.50
Cockpit	367.36	390.43	23.07
Propulsion	886.08	974.66	88.58
GE Propulsion	2641.50	2730.16	88.66
Tail and Aft Fuselage	723.31	742.22	18.91
Wing	995.58	1003.05	7.47
TOTALS	7502.85 lbs.	7879.09 lbs.	376.24 lbs.

reverser door modification, and improved insulation around fan ducting. An itemized listing of changes causing weight increase or decrease since the aircraft entered ground functional tests is presented in Table II.

c) Flutter and Vibration

1) Progress

During the reporting period, the main effect of the unit was centered on writing of required reports. Work was continued on the ground vibration test results, preliminary flutter analysis results, preliminary vibration and acoustic environmental study and also acoustic test results. In addition to the foregoing report preparation, test plans were formulated for a modal survey of the reworked empennage (required for flutter purposes), scheduled to take place during the month of September at Edwards Air Force Base.

2. Schedule

a) Stress Analysis

Stress analysis was on schedule at the close of this period.

b) Weight Control

The weight control effort is keeping pace with flight test activities, and is on schedule.

c) Flutter and Vibration

Scheduled release of required reports have experienced some slippage. Two additional flutter analysis engineers have been acquired to augment this effort.

3. Plans for Next Quarter

Plans for next quarter include:

a) Stress Analysis

During the next reporting period, continued ground and flight test support will be performed as required. In addition, the Stress Analysis Report on the engine

TABLE II

WEIGHT CHANGES

1.	Additional items as result of fire damage			
	Additional access panels installed		9.60	
	Use of waffle stainless insulation in place of fiberglas at cross ducts	9.84		
	at pitch fan ducts	16.10	25.94	
	Additional engine bay drains		5.26	
				40.80
2.	Additional heat changes as result of ground tests			
	Pitch fan mount structure insulation		3.56	
	Main landing gear insulation and shielding		33.24	
	Wiring insulation		0.39	
	Aft fuel tank insulation		3.36	
	Aft fuselage insulation		3.93	
	Aft fuselage deflection strokes		12.90	
	Added finger seals at tailpipe exit		1.20	
	Deflector baffle plates for J85 cooling		0.38	
	Resistor box in fire detector and overheat circuits		0.27	
				59.23
3.	Nose gear change			
	New shimmy damper and gear beef-up			16.48
4.	Exit louver actuation changes			
	Increased size of hydraulic actuators		29.02	
	New actuator brackets		17.21	
	New actuator fiberglas fairings		2.83	
	Rework to lift fan rear frame beef-up		8.00	
	New push rods and cam links		19.36	
				76.42

WEIGHT CHANGES

5.	Stiffened exit louvers for increased roll power and fatigue life		48.00
6.	Full scale wind tunnel changes		
	Lift fan inlet vane modifications	12.00	
	Increase material and doublers on strut fairing	2.01	
			14.01
7.	Increased pitch fan performance		
	Pitch fan center strut addition	6.00	
	Addition of reverser door turning vane	22.56	
	Addition of reverser door vibration damper	4.82	
			33.38
8.	Bracing added to stiffen space frame struts		3.42
9.	Control improvements		
	Reduction of elevator balance weight	-3.72	
	Aluminum changed to steel conduit - mixer box teleflex	0.5	
	Push-pull rod system utilized to replace mixer cables	2.85	
	Cover added to mechanical mixer	2.27	
	Phase adapter added for landing gear time delay	1.48	
	Plastic wire clamps replaced by cushion type	4.00	
	Cover added to generator control panels	0.32	
	Material change to circuit breaker panels	0.50	
	Horizontal stabilizer motion warning system	1.97	
	Records adjustment for aileron tabs and supports	3.50	
	Use of flex hydraulic hoses to replace rigid lines	4.36	

WEIGHT CHANGES

Revised gyro package	1.74	
Increase resonant frequency of control stick	0.45	
Stiffened control pulley bracket	0.50	
Miscellaneous changes	3.06	
		23.78
10. Landing gear changes		
Adjustment for master cylinder weight (entered twice)	-2.52	
Abutment stops added to drag brace	2.50	
Gear struts change from aluminum to steel	2.77	
Braces added to gear stabilizer beams	3.40	
Retractor added to gear uplatch	0.81	
Spacers and bolts added to gear support structure	0.62	
Standpipe added to master cylinder	1.50	
		9.08
11. Propulsion group changes		
Stiffeners and doublers added to cooling fan	1.93	
Tailpipe shroud reinforcements added	7.56	
Thrust spoiler stock thickness increase	3.84	
Compressor bleed ducts changed to steel	1.48	
Ducting added for pitch fan inlet air pump	0.69	
Rework of pitch fan inlet louvers	2.38	
Correction of error on duct bellows	-11.44	
Test insulation - not A/C component	- 6.64	
Miscellaneous changes	- 4.25	
Stiffening of pitch fan bellmouth	3.00	
		-1.45

WEIGHT CHANGES

12.	Results from stall investigation		
	Addition of ejector for added J85 cooling	10.00	
	J85 inlet modification	10.55	
			20.55
13.	Miscellaneous weight changes		
	Flap actuator lighter than estimated	-3.50	
	Canopy latch torque tube changed to steel	1.26	
	Horizontal stabilizer stiffness increased	4.49	
	Increased oxygen system capacity	18.50	
	Miscellaneous forward fuselage changes	1.12	
	Miscellaneous cockpit changes	3.90	
	Miscellaneous tail and aft fuselage changes	2.50	
	Miscellaneous wing changes	1.21	
	Miscellaneous electrical system changes	1.80	
			31.28

inlet, thrust spoilers and pitch fan inlet louver installation will be completed and submitted.

b) Weight Control

Plans for the next quarter include continuation of the weight control effort and preparation of the Final Weight and Balance Report.

c) Flutter and Vibration

Completion and release of reports is presently contemplated for the next quarter. Carrying out of the empennage shake test and reduction of data will be completed during the next period, in addition to establishment of coordination channels with flight test personnel at Edwards Air Force Base and structural dynamics personnel, in order to implement flutter flight test requirements.

E. THERMODYNAMICS

1. Progress

During this period, the aerodynamic effort included on-site support of the tie-down propulsion and 40' x 80' wind tunnel test programs on Aircraft Number 1 (S/N 24505) at NASA-Ames, and of the flight test program on Aircraft Number 2 (S/N 24506); final report preparation; and investigations of a number of special problems in support of the XV-5A program.

Results from the test programs at NASA-Ames were quite encouraging. Subjected to severe test conditions (the aircraft was operated for periods of 30 to 45 minutes in fan mode at powers to 96% J85 RPM in and out of ground effect), the test program was carried out with only minor interruption due to overheating. Although allowable temperature limits were higher for these tests than those permitted in flight testing (see Quarterly Progress Report No. 10), there appeared to be ample performance margin for the flight test program to progress without undue incidents arising from overheating. Significant hot gas ingestion was noted at $h/_D$ = 1.0 and $h/_D$ = 2.0 during ramp tests, which could be related to various aircraft control inputs. Incremental temperature increases to 70°F were noted for

the engine air inlet, and to 100°F for the cooling system air inlets. Occasional ground winds to 15 knots occurred during some tests. No engine operating problems were experienced during the ramp tests.

Based largely on the Ames test data, estimates of allowable operating times were made for the flight test program conducted at Edwards Air Force Base, at ambient temperatures to 110°F. These estimates indicated sufficient operating time to explore fan mode flight regimes in a practical manner.

A main landing gear door investigation was completed. Utilizing XV-5A Ames wind tunnel and ground test data, estimated hot gas isotherms were prepared, Figure 18. Data in Figure 19 show surface temperature estimates with insulation applied to the exterior of the main landing gear door for different hot gas temperatures and insulation thickness. It can be seen in Figure 20 that approximately 1/8" insulation should permit an allowable exposure time of 4.25 minutes for hot gases at 860°F. This compares with the 5 minute requirement which is believed somewhat excessive; a value of 2 minutes is considered more reasonable. During the time periods involved, no violation of the MLG wheel well temperature limits is expected. For these reasons, the recommended insulation is believed adequate for flight tests. In addition to the insulation, reasonable precautions will be taken to prevent hot gas leakage into the MLG wheel well along closure and hinge regions.

Two reports were completed. The first, Ryan Report 64B015, "Calculated Installed Power Plant Performance, U.S. Army XV-5A Lift Fan Aircraft", has been published and released. The second, Ryan Report 64B016, "Wind Tunnel Test Report of 1/5 Scale Inlet Model, U.S. Army XV-5A Lift Fan Research Aircraft", has been released for publication and will be issued shortly.

Effort has continued on Ryan Report 64B017, "Calculated Heat Transfer and Cooling System Performance, U.S. Army XV-5A Lift Fan Research Aircraft", which was 75% complete at the end of this period.

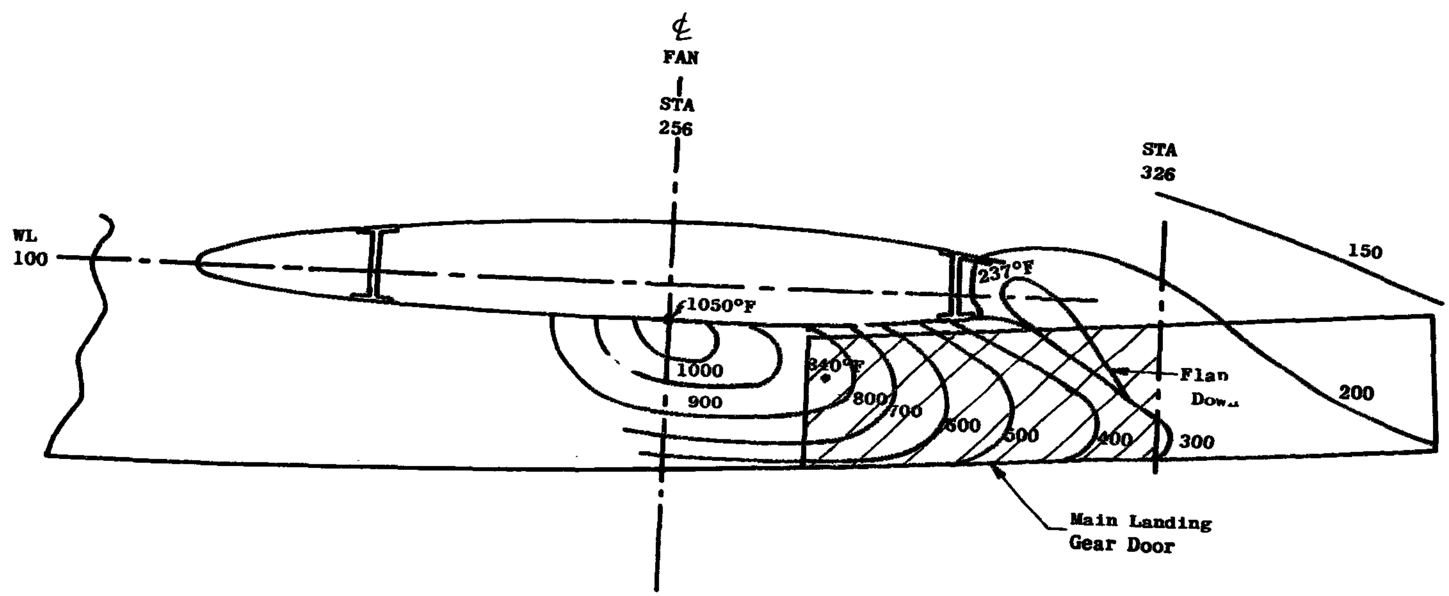


Figure 18. Estimated Main Landing Gear Door Isotherms - VTOL Mode. $\beta_V = 44°$, $V_K = 96$ Knots, Hot Day - 2,500 ft., 100% RPM.

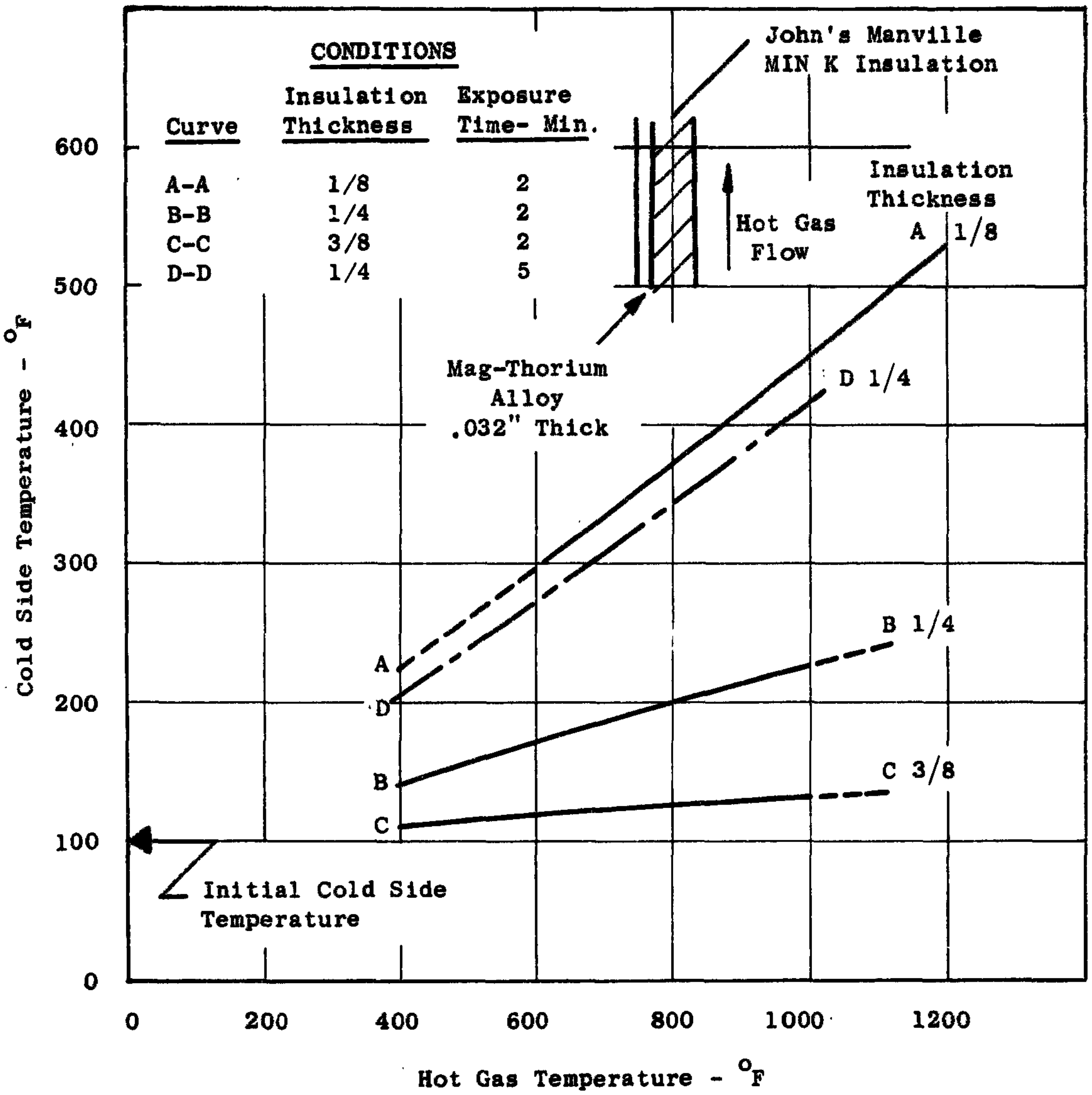


Figure 19. Effect of Insulation Thickness on Cold Side Temperature vs Hot Side Gas Temperature.

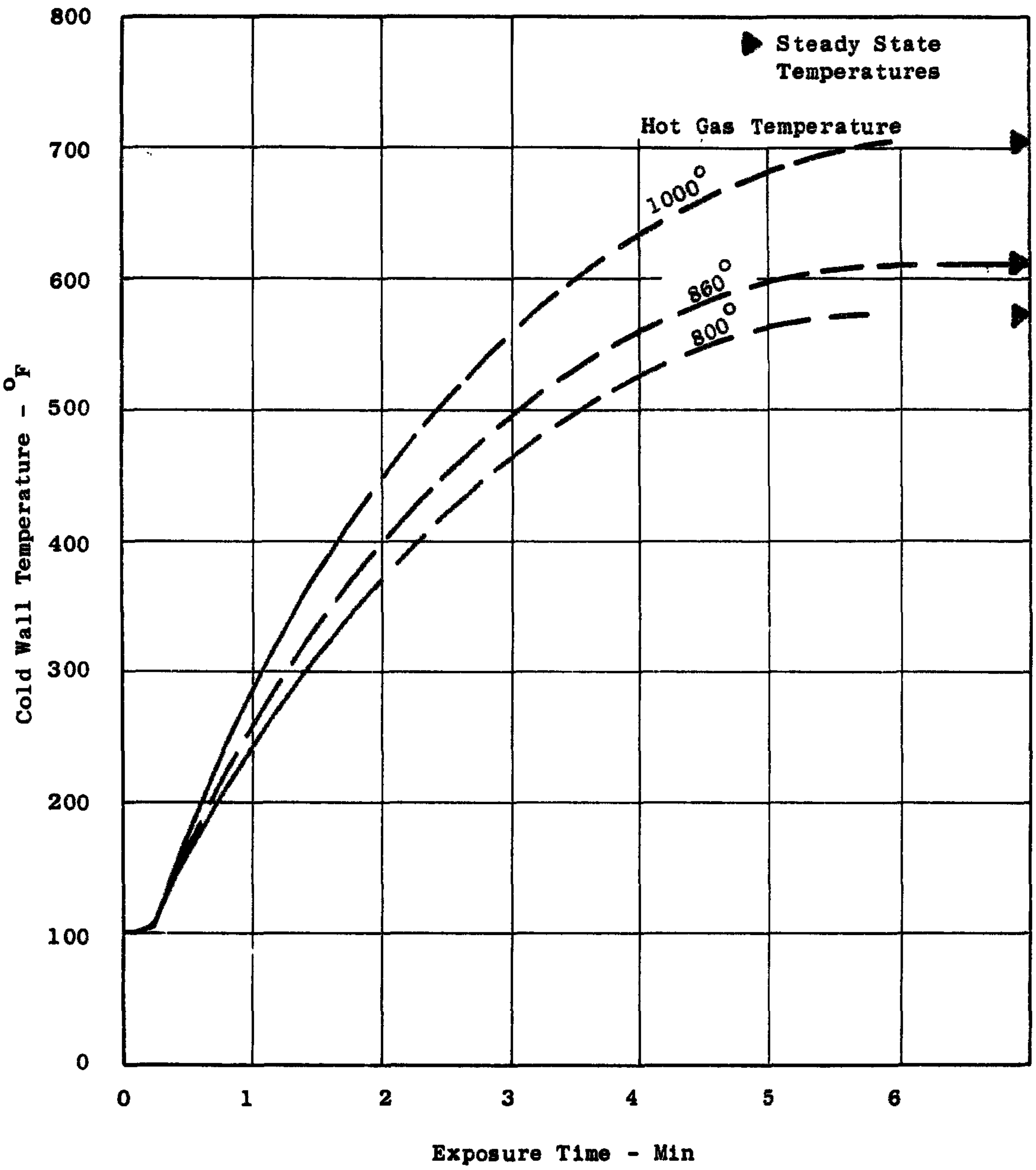


Figure 20. Estimated Temperature - Time Profile of 0.032" MLG Door Skin Covered with 0.125" Johns Manville MIN K Insulation.

Investigations underway at the close of this period included:

a) Comparison of general aircraft temperature levels during fan mode operation with and without the pitch fan operative.

b) Survey of aircraft surface pressures and other data to discover possible cooling system air inlet locations less subject to hot gas ingestion.

c) Evaluation of various ways of combating engine stall problems encountered during Aircraft Number 2 testing at Edwards Air Force Base.

2. Schedule

Except for Report 64B017, the Thermodynamics work is on schedule.

3. Plans for Continuing

Except for unforeseen developments, Report 64B017, Heating and Cooling Analysis, will be completed during the next quarter. In addition, support of the flight test program at Edwards Air Force Base will be continued.

F. RELIABILITY

1. Progress

a) Electrical System

During the previously reported XV-5A Simulator Failure Analysis it was discovered that under certain conditions the pilot could place the aircraft in a "split mode" configuration. That is, with the horizontal stabilizer position and diverter valve position out of phase with each other. A coordinated Reliability/ Electrical Group Analysis resulted in recommended wiring changes to the Flight Conversion Control System that would eliminate the possibility of Split Mode occurring. These circuit changes were approved and have been incorporated in the aircraft. In addition, these changes also corrected a circular deficiency that permitted loss of the "FAN POSITION" signal to the diverter valve actuators from a momentary low voltage buss condition.

Studied Horizontal Stabilizer control system to evaluate various methods of safely positioning stabilizer at incidence angles inside the normal design limits for a stabilizer slat evaluation. Recommended use of emergency trim system, and provided Electrical Group with data to prepare a special flight procedure for Horizontal Stabilizer Positioning for VTOL testing.

b) Stability Augmentation System

Completed analysis of proposed Control Stability Augmentation System Input Generator. No significant reliability degradation could be attributed to the input generator. However, the proposed pilot operated controls would have compromised positive pilot control of the aircraft during the test, and could have a detractive effect on the test results. Recommended changes to the pilot operated controls were accepted and incorporated in the aircraft installation.

c) Modified Louver Actuator/Fan Tests

The Reliability Group performed a continuous reliability review and analysis of hydraulic actuators, fan structure and operating mechanism modifications during design. A Reliability Representative participated in the fan assembly tests, performed in the Ryan Hydraulic Test Laboratory, and provided technical assistance to the Ryan Quality Control witnesses.

d) XV-5A Flight Manual

Completed progressive reviews and final editing of the XV-5A Flight Manual, Section II - Normal Procedures (Advance Issue).

e) Pre-Hover Pilot Briefing

Just prior to the July hover flight tests, a flight safety refresher pilot briefing was conducted. In this discussion the following subjects were reviewed.

1) Basic systems, including hydraulics and controls, AC and DC power and distribution systems, conversion control electrical system - Primary and Standby operation and controls, cockpit arrangement, instruments and operation.

2) Standard Operating Procedures.

3) Emergency Systems Operation, including fire warning and extinguishing system, structural overheat warning system.

4) Summary of Fan Mode (excluding conversion) failures and corrective actions derived from simulator study including:

   Stability Augmentation System Failures, Horizontal Stabilizer Control System Malfunctions, and Thrust Vector Actuator Programmer Malfunctions.

5) Single Engine (Fan Mode) Recovery Envelope.

f) XV-5A Field Failure Reporting Program

The Field Failure Reporting form was revised to provide reporting space for operational data peculiar to the XV-5A Program and to record maintainability data.

An IBM 704 Digital Computer Program to provide periodic summary listings of XV-5A component failure history listings has been completed. A sample listing is shown on Table III.

g) Simulator Failure Study

The Simulator Failure Study data has been reviewed. Significant data from selected representative test cases has been reduced and organized for final analysis. These test cases include the following system failures:

Single engine, horizontal stabilizer control, stability augmentation system, fan overspeed control, thrust vector actuator programmer.

2. Plans for Continuing

Plans for continuing next quarter include:

a) Completion of Simulator Failure Study Report.

b) Prepare the reliability portion of the Flightworthiness Report.

TABLE III

XV-5A COMPONENT FAILURE HISTORY

21, AUGUST, 1964

SUMMATION TO [illegible]

S/S COD	SYSTEM SER.NO.	PART NAME	PART NUMBER	PART SERIAL NO.	FAIL DATE	OPER MODE	OPERATING TIME OR CYCLES	FLIGHT SAFETY	REPORT NUMBER
[illegible]	4506	ROLL TRIM ACT[illegible]	[illegible]	[illegible]	[illegible]	T/O	[illegible] HRS SINCE NEW	[illegible]	[illegible]
[illegible]	45[illegible]6	ACT[illegible]	[illegible]	[illegible]	[illegible]/64	[illegible]	[illegible] HRS SINCE NEW	NO	[illegible]
[illegible]	4505	FLAP ACT MTR	[illegible]	[illegible]	[illegible]	[illegible]	UKN. HRS SINCE NEW	NO	[illegible]
[illegible]	45[illegible]	FLAP ACT [illegible]	[illegible]	[illegible]	[illegible]	T/O	UKN. HRS SINCE NEW	NO	10[illegible]
	45[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] HRS SINCE NEW	NO	[illegible]
[illegible]	45[illegible]	SWITCH [illegible]	1L1325-[illegible]29	34108	0306	MAIN	0000.0 HRS SINCE NEW	YES	[illegible]
[illegible]	4506	SWITCH [illegible] PR	1L1325-030	[illegible]	[illegible]	T/O	UKN. HRS SINCE NEW	NO	[illegible]
[illegible]	[illegible]	SWITCH [illegible] PR	1L1325-030	35076	[illegible]	T/O	0000.0 HRS SINCE NEW	NO	[illegible]
[illegible]	45[illegible]	SWITCH [illegible] PR	1L1325-030	341[illegible]	[illegible]/64	MAIN	00[illegible] HRS SINCE NEW	NO	[illegible]
[illegible]	[illegible]	SWITCH [illegible] PR	1L1325-030	UNKNOWN	UNK	PRE	[illegible] SINCE NEW	[illegible]	[illegible]
[illegible]	45[illegible]	[illegible]	[illegible]		[illegible]/64	INSP	0000.0 HRS SINCE NEW	[illegible]	[illegible]
[illegible]	45[illegible]	FLAP POT [illegible]	[illegible]	[illegible]	07/07/64	T/O	0040.0 HRS SINCE NEW	NO	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		02/18/64	C	[illegible] HR SINCE NEW	[illegible]	[illegible]
	45[illegible]	[illegible]	[illegible]	[illegible]	04/[illegible]/64	TAXI	UKN. HRS SINCE NEW	YES	[illegible]
	45[illegible]	[illegible]	[illegible]	[illegible]	04/08/64	TAXI	UKN. HRS SINCE NEW	YES	[illegible]
	45[illegible]	TIRE	[illegible]-TY VII	[illegible]	[illegible]/18/64	POST	UKN. HRS SINCE NEW	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	NONE	[illegible]/64	TAXI	UKN. HRS SINCE NEW	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	AV[illegible]1103	[illegible]-000[illegible]	0316	MAIN	UKN. HRS SINCE NEW	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]-000[illegible]	0319	[illegible]	0000.0 HRS SINCE NEW	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]/64	INSP	[illegible] SINCE NEW	NO	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	02/29/64	T/O	0002.0 HRS SINCE NEW	NO	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0305	T/O	0020.1 HRS SINCE NEW	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	NONE	[illegible]/64	[illegible]	UKN. HRS SINCE NEW		
	[illegible]	[illegible]	291314	4	05/06/64	SIM	0000.0 HRS SINCE REWK	NO	[illegible]
[illegible]	[illegible]	[illegible]	291314	2	[illegible]	MAIN	UKN. HRS SINCE REWK	YES	[illegible]

XV-5A COMPONENT FAILURE HISTORY

[illegible]

[illegible]

[illegible]	PART NAME	PART NUMBER	PART SERIAL NO.	FAIL DATE	OPER MODE	OPERATING TIME OR CYCLES	FLIGHT SAFETY	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0319	T/O	[illegible] HR SINCE NEW	[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0000.0 HRS SINCE NEW	[illegible]	[illegible]

G. STRUCTURAL AND SYSTEMS DESIGN

1. Progress

During the close of the last reporting period design effort was concentrated on the roll control problem, defining aircraft change requirements in the areas of wing fan exit louver actuators, brackets, actuator fairings, and mechanical mixer box changes to provide additional roll control power. The new parts were installed on a General Electric spare fan in a Ryan hydraulic and controls laboratory, for qualification tests of the actuator, and actuation hardware. Initial tests resulted in premature failures of some of the components, which were modified, resulting in successfully completing the qualification tests.

The Final XV-5A Maintenance Manual, Ryan Report 14359-13, was completed and distributed. This report is a culmination of all checkout and maintenance procedures as developed during ground tests at Ryan, including major equipment item servicing and checkout information. The manual is being utilized by the Flight Test Group and will be updated periodically, based on actual service experience.

The Design Group pursued a modified wing fan door seal investigation to improve the sealing between the wing fan closure door and the wing fan bellmouth. A test specimen was statically loaded to evaluate required spring rate of the backup spring plate on top of the original rubberized seal With this test successfully completed, engineering was released and the revised seal was installed on the aircraft at Edwards Air Force Base.

The end of the last reporting period coincided with the completion of the test program on the modified nose gear conducted at the Lockheed Rye Canyon Shimmy Test Drum Facility. The modified nose gear indicated shimmy-free operation up to taxi speeds in excess of 125 knots under driven and shimmy conditions.

The modified nose gear and shimmy damper tested at the Rye Canyon Facility were designed to meet torsional and lateral stiffness, and damping coefficient requirements derived from theoretical computer analysis conducted at Ryan during the last quarter. This analysis was performed by a joint Ryan/Republic Engineering team. Figure 21 illustrates the nose gear shimmy investigation study, comparing predicted

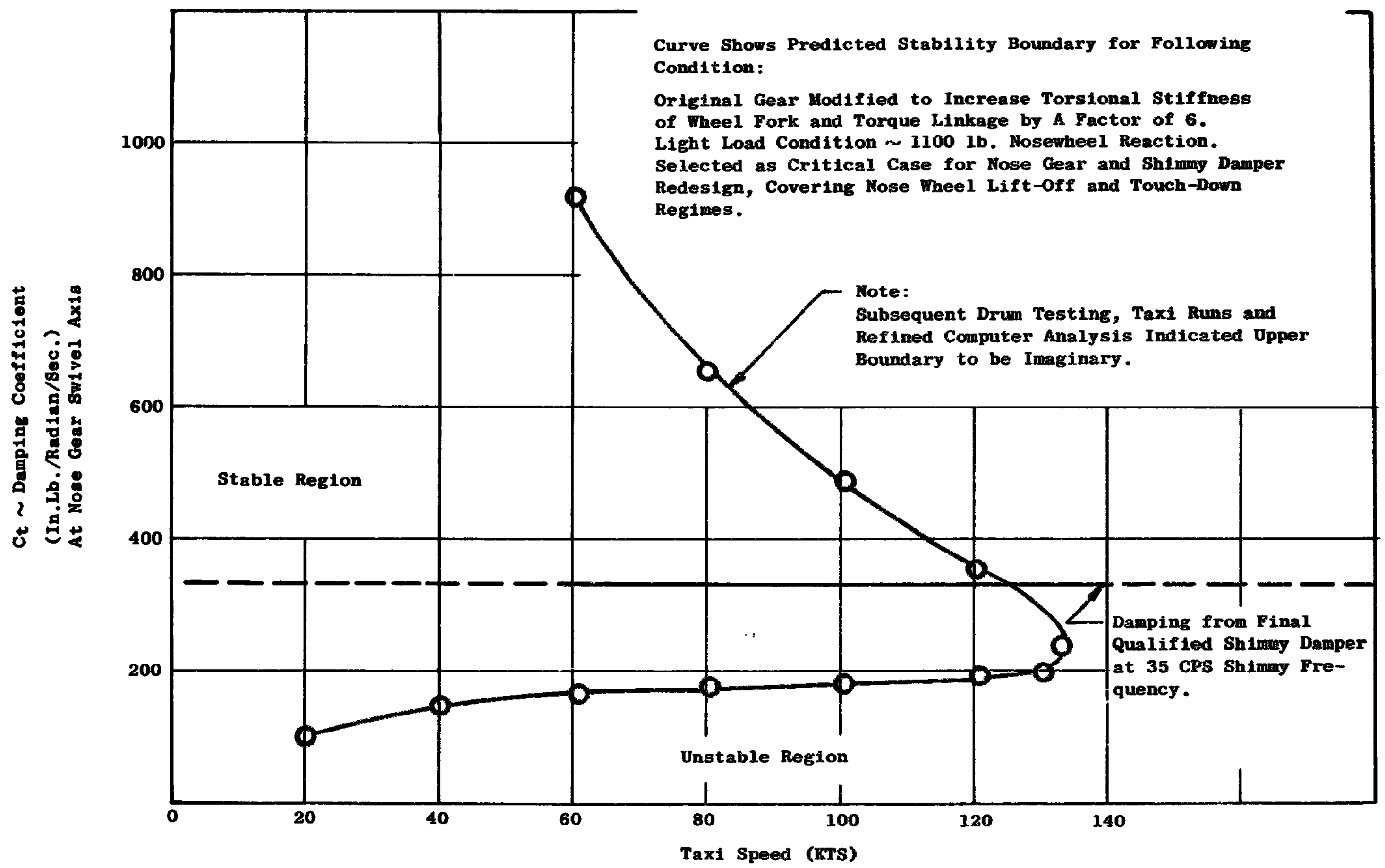


Figure 21. Analog Study (Modified Gear) -
Nose Gear Shimmy Investigation.

stability boundary for various conditions, and illustrates the damping level ventured during the final qualification of the revised shimmy damper. Figure 22 illustrates the original damper performance versus the final damper performance.

Detailed redesign and testing of the damper, nose wheel fork, axial retention, and torque links was performed by the landing gear vendor with assistance from the Ryan Design Group. These tests were completed before commencement of the Rye Canyon drum testing.

The drum testing satisfactorily confirmed the predicted lower boundary of nose gear damping required to suppress shimmy, but did not confirm the theoretical prediction of an upper limit to the damping coefficient. In order to resolve this discrepancy, the modified nose gear was installed on Ship No. 2 at Edwards Air Force Base. Measurements were made of the dynamic lateral bending stiffness and frequency response of the nose gear/airframe combination. Using this data, combined with data from the shimmy drum tests, a refined digital computer analysis was performed which did correlate with the observed behavior of the landing gear system on the Rye Canyon shimmy test drum. With satisfactory matching of the airframe/nose gear characteristics having been achieved, the aircraft was cleared for continuation of taxi testing. High speed taxi tests indicated satisfactory shimmy suppression up to the nose gear liftoff speeds. No nose gear shimmy problems were encountered during subsequent flight testing.

The nose gear shimmy damper was subjected to environmental qualification tests and passed successfully. The modified shimmy damper used on the shimmy drum and during the first series of conventional flights, was in prototype unit with no thermal composition devices installed. The damper for the second nose gear for Ship No. 1 was subjected to environmental and life testing, which passed all tests satisfactorily after minor modifications. A silicone fluid was substituted as the damping medium, in place of the castor oil used previously. The dampers on both aircraft had been reworked to the qualified configuration. Figure 23 illustrates the performance improvement of the damper during the development period.

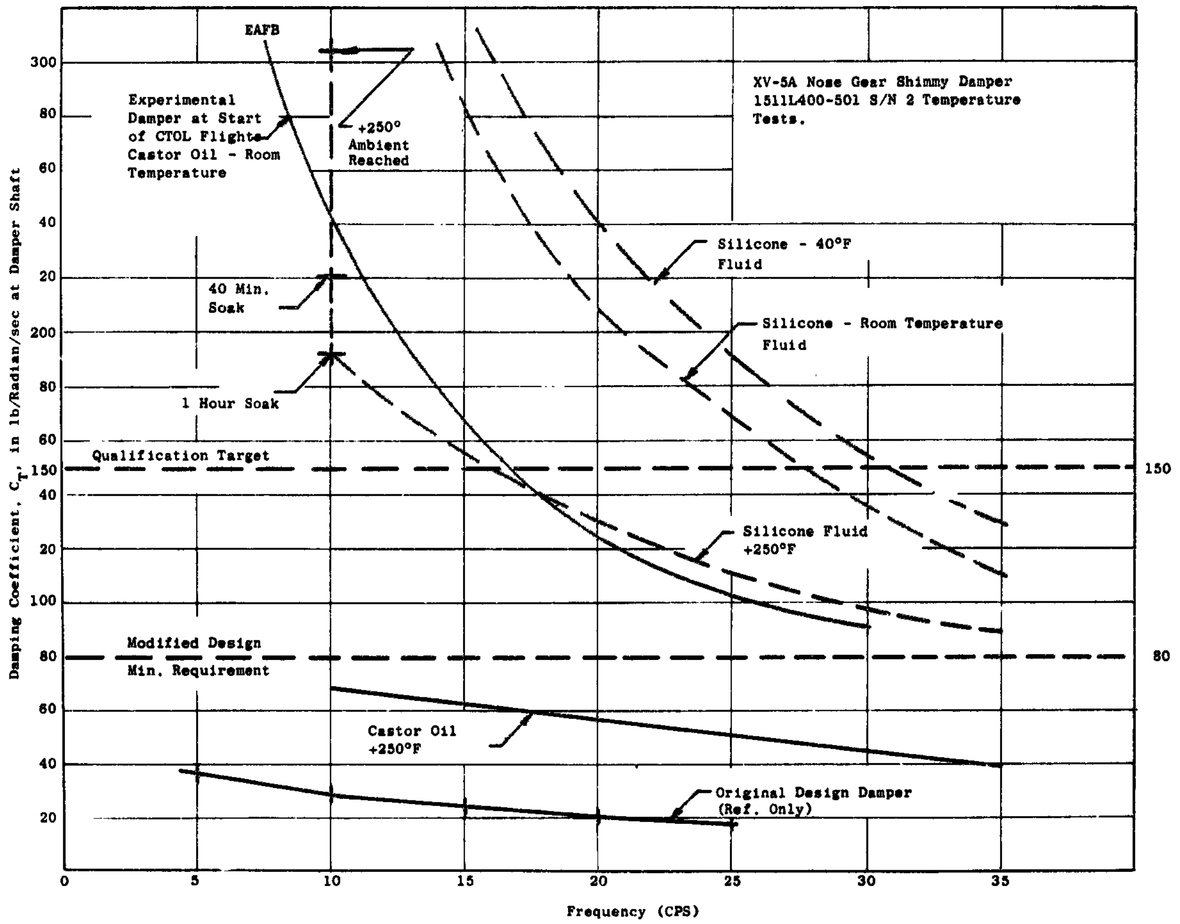


Figure 22. Damper Performance Comparison.

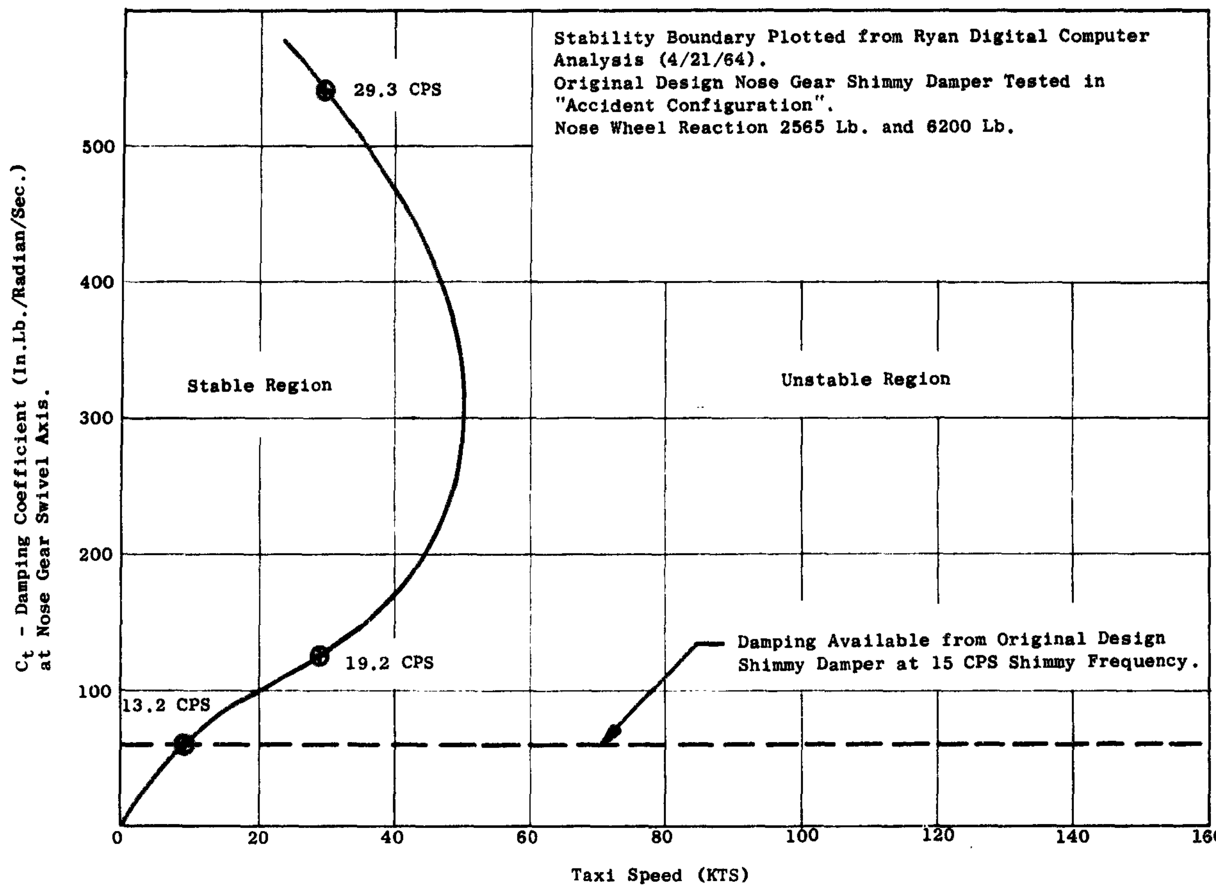


Figure 23. Damper Improvement During Development Testing.

The Design Group provided engineering for aircraft changes determined desirable at the Flight Test Center. Major changes included:

a. Redesigned the nose landing gear door to accommodate the larger shimmy damper.

b. Designed improved accessibility of the main landing gear uplatch toggle linkage.

c. Improved wing fan closure seal to provide longer life and provide better contact with the fan bellmouth where bellmouth contour irregularities exist.

d. Designed additional longerons for the titanium canoe fairing, to prolong fairing life due to temperature and noise fatigue problems.

e. Completed the design of the horizontal stabilizer slat. This slat, shown in Figure 9, will be installed on Ship No. 2 during the transition buildup phase, to provide added longitudinal control margin. A similar slat was tested in the NASA-Ames 40' x 80' wind tunnel and provided performance information of the slat design. After demonstrating sufficient longitudinal control margin, the slat will be removed for subsequent flight testing.

f. In support of the engine stall investigation effort at Edwards, the Design Group designed an engine inlet modification which incorporated film cooling slots in the engine induction throat of the inlet. These slots provide air which enters access openings on top of the engine inlet and into the air induction inlet. In addition, ejector cooling tubes were designed for installation in the engine compressor compartment to promote better cooling during fan operations

2. Schedule

The structure and system design effort was on schedule at the close of this period.

3. **Plans for Continuing**

Support of flight test will continue next quarter.

III. MANUFACTURING

A. FABRICATION

1. Progress

At the end of this reporting period, Ship No 2 was completed with the exception of continual design changes required from flight test experience. Ship No. 1 had been shipped from NASA-Ames to Edwards and was undergoing refurbishing in preparation for joining Ship No. 2 in flight test.

Detail parts fabrication at San Diego included repair and replacement of damaged parts as a result of the nose gear collapse during initial high speed taxi tests. Manufacturing also provided new aircraft parts to accommodate the larger fan exit louver actuators. Parts were also manufactured for Ship No. 1 to support the post wind tunnel test refurbishing effort.

Other manufacturing tasks completed included repair of the titanium canoe fairing, tooled up for the horizontal stabilizer slat, installed improved wing fan closure seals, and fabricated engine compartment cooling ejector tubes.

The new pitch fan inlet actuators were in final qualification testing and are expected to be at Edwards early in September, 1964. The actuators are designed to impose a higher preload pressure on the pitch fan louver and their stops, which will eliminate the flutter tendency experienced when the louvers are open. The Manufacturing and Quality Control Departments provided a full time Liaison Engineer at the vendor's plant to augment final assembly checkout and qualification tests.

Status of all the propulsion hardware necessary for the exit louver actuation modification is as follows:

1) All rear frames, with the exception of the frame on fan S/N 008, have been modified to accept the new hardware.

2) Fans S/N 004 and S/N 007 have been completely equipped and are installed in A/C #2 at Edwards.

3) The cams, links and pushrods for fans S/N 005 and S/N 006 are scheduled for delivery September 25, 1964 and the hardware for the two spare fans by October 16, 1964.

2. Schedule

Dual shift operations at Edwards and many long days have kept the Manufacturing and Maintenance efforts on schedule.

3. Plans for Continuing

Plans for continuing next quarter include completing Ship No. 1 to join Ship No. 2 in flight test, and supporting both aircraft through completion of the Flight Test Program.

IV. GROUND TEST

A. SAN DIEGO EFFORT

1. Progress

The Hydraulic and Controls Simulator was updated to the hardware configuration of the flight vehicles. Systems functional tests were repeated, including procedure revisions determined during aircraft functional tests. The Analog Computer was being rewired for continuing simulation in support of flight test. Changes have been incorporated, such as the roll control power increase. The simulator updating is on schedule and will be completed by September 7, 1964.

The major effort during this quarter was ground test effort in support of the roll control problem. A test of the new wing fan exit louver actuator installed on the General Electric 003 spare fan was completed. Ryan Report 64B109, dated July 15, 1964, presents the test procedures and results.

The purpose of this test was to submit the wing fan exit louver actuation system to qualification testing of the new actuators and mounting provisions, revised fan strut attachment, fan pushrods, and modified 0° and 40° stagger stops. The test was representative of an estimated 250 hours of flight cycles, including anticipated hangar inspection cycling. The test also included proof loading of the 40° and 0° stagger stops, cam scrubbing and impact cycling at selected vector settings.

The tests were conducted in the Hydraulic and Controls Lab., see Figure 24. Tests were completed successfully with only normal life testing wear observed during port test tear-down inspection.

The Installed Systems Functional Test Report, Ryan Report 64B089, dated August 8, 1964, was completed and issued. This report presents the test procedures and results of systems functional tests conducted last quarter prior to shipping the aircraft to flight and wind tunnel test sites.

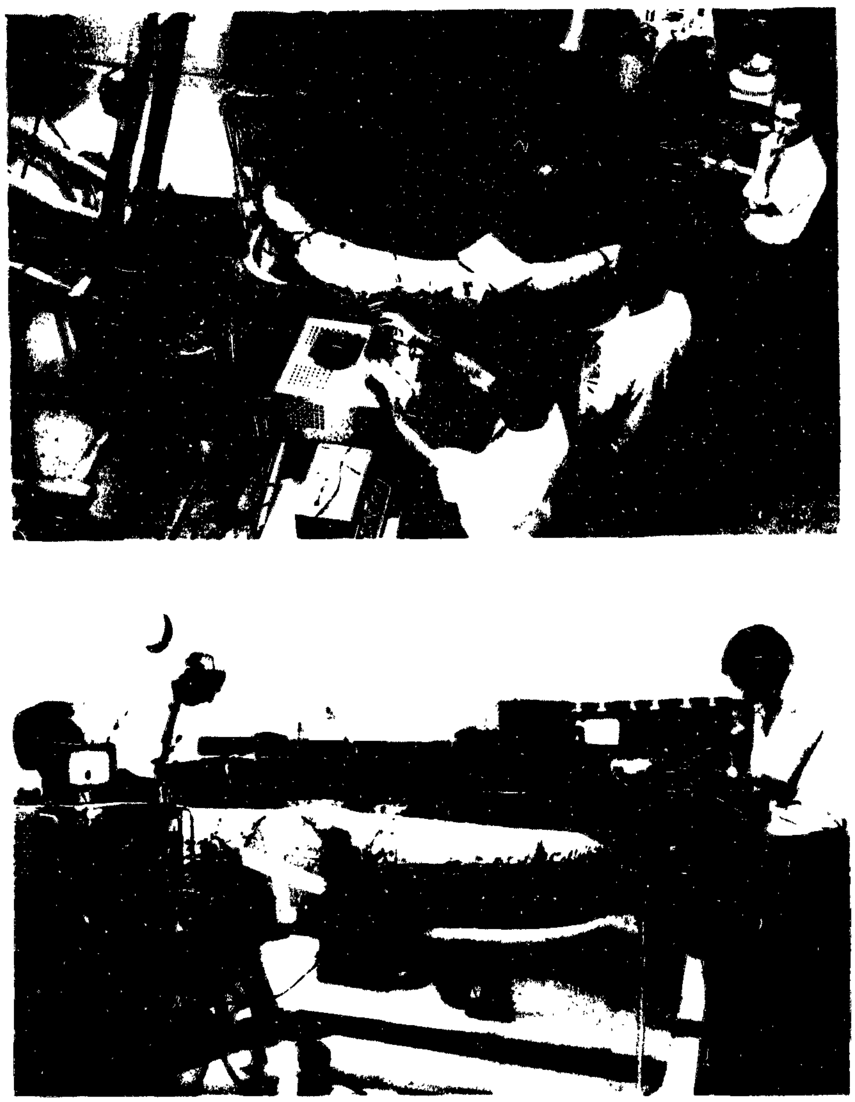


Figure 24. Test Set-Up.

The XV-5A Wind Tunnel Program conducted at NASA-Ames was completed. Ground static thrust stand tests and wind tunnel test results were instrumental in providing design information to resolve the roll control problem, and in supplying stability and control performance data to augment the flight test program. Data reduction of NASA-Ames tests was being continued at the close of this period.

Ship No. 1 was received at Edwards Air Force Base July 22, 1964 after transshipment from NASA-Ames via San Diego.

B. EDWARDS AIR FORCE BASE EFFORT

1. Progress

At the close of last quarter, May 15, 1964, Ship No. 2 was prepared for continuation of flight testing. The damage caused by the nose gear failure was almost complete, and system rigging and checkout was in progress.

During the middle of May, the Ground Test Group conducted a shake test on the revised nose gear to provide dynamic data for inclusion into the nose gear shimmy analog computer program.

During the first week in June, calibration of the Edwards VTOL thrust stand began utilizing the adapter cradle supplied by Ryan. A thrust stand test run schedule and additional instrumentation were prepared. Engine runs and functional tests of the wing fan louver system were completed July 3, 1964. Thrust stand tests were completed the following week.

During the thrust stand tests and subsequent tie-down propulsion tests, a series of engine stalls were encountered. During the initial hovering flights, compressor stalls were experienced, and the aircraft was installed on the VTOL tie-down ramp for stall investigation testing. On July 23, 1964, during hovering flight, a compressor stall during landing was experienced. Ship No. 2 was reinstalled on the VTOL thrust stand for tests to evaluate the cause of engine stalls. Several aircraft modifications were incorporated and numerous instrumentation additions were incorporated. The ground run activity continued until August 15, 1964, when hovering flight testing continued with no further evidence of the stall problem.

2. Schedule

The ground test effort was on schedule at the end of this quarter.

3. Plans for Next Quarter

Plans for continuing include ground runs as necessary to support flight testing and functional tests of Ship No. 1 preparatory to entering flight test.

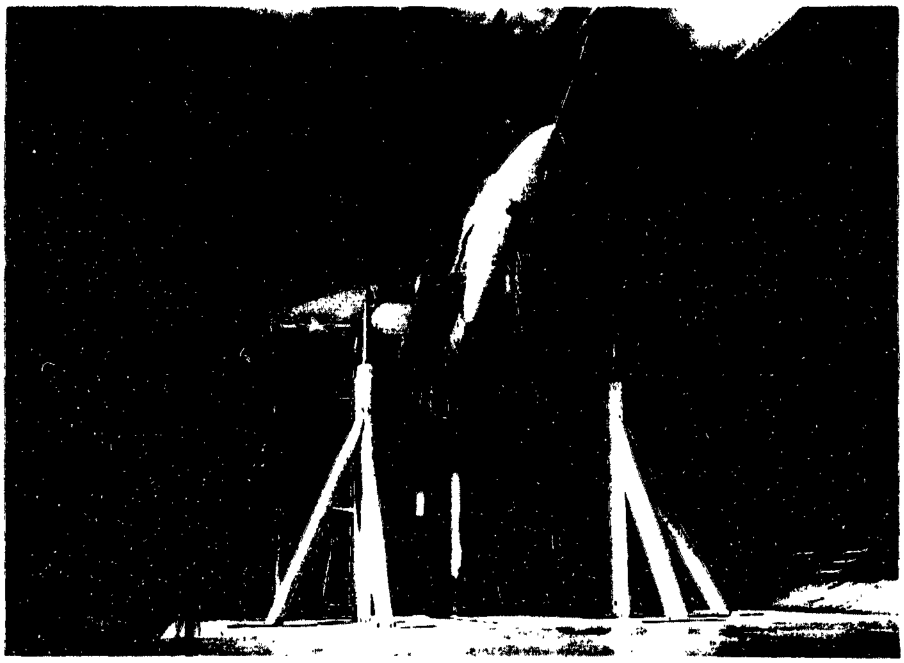
C. NASA-AMES EFFORT

1. Progress

During this reporting period, the full scale wind tunnel program was completed. The aircraft was installed in the wind tunnel on May 19, 1964 and all tests were completed on June 18, 1964 (Figure 25).

The test program included complete investigation of the aircraft flight envelope during both powered and unpowered flight. The range of test variables included flight speeds from hover to approximately 100 knots. During this range of test conditions, effects of such variables as angle of attack, sideslip, and control inputs were investigated. Based on preliminary analysis of the data, the aircraft appeared to perform as predicted throughout the conditions investigated, except in terms of longitudinal stability at high angles of attack. At flight speeds of 40 to 60 knots, data on longitudinal stability derivatives appeared to indicate a sharp break toward a more unstable system. Improvements were investigated through the use of tufts, and larger horizontal tail surface, as well as leading edge slats. Section II of this report describes some of these results in more detail.

Several mechanical failures occurred during this test phase; wing fan circular inlet vanes, and rupture of the sideplates on the wing fan strut fairings. Details of these items are described elsewhere in this report.



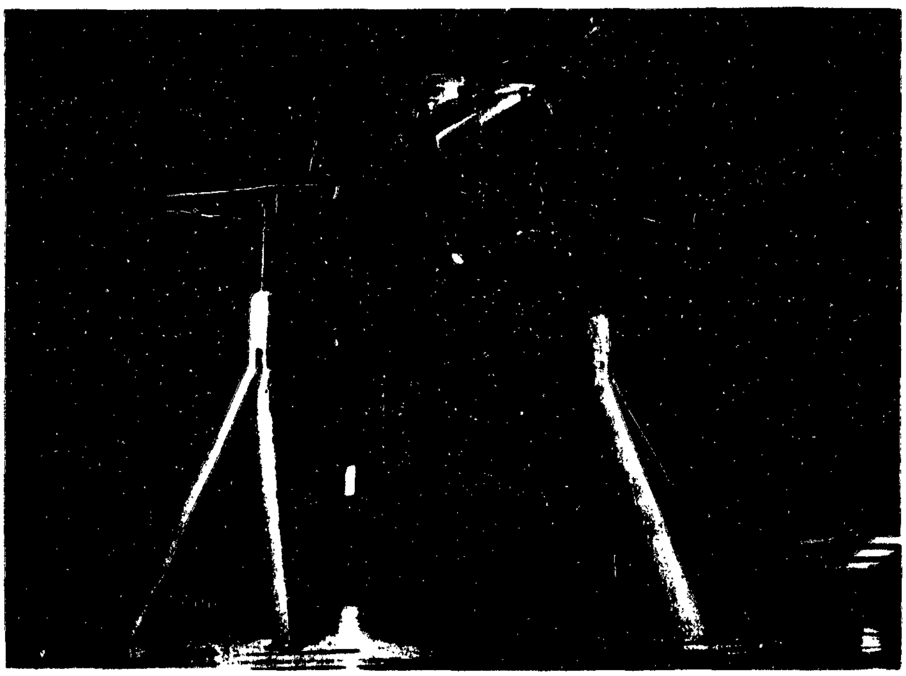


Figure 25. Views of XV-5A A/C # 1 Installed in NASA Ames Wind Tunnel.

The following summarizes the wind tunnel test program in terms of operating time and data obtained:

Total tunnel test hours	-	27.2
J85 engine hours	-	21.0
Fan operation hours	-	15.3
Total data points	-	815*

* Each data point has approximately 150 recorded parameters.

Following the wind tunnel test program, the aircraft was reinstalled on the static thrust stand to investigate the apparent roll moments experienced during the initial static stand test. The force measurement system was refined prior to this test phase, to provide better measurement accuracy. An abbreviated test program was run on the static thrust stand to investigate control effectiveness, both in and out of ground effect. Evaluation of these test results are still in progress.

2. Plans for Next Quarter

Continued evaluation of the wind tunnel test results and preparation of the final test report are the next quarter plans.

V. FLIGHT TEST

A. TEST PROGRAM DEVELOPMENT

Approval for resumption of high speed taxi tests was received the afternoon of May 21, 1964, with the first taxi test successfully conducted July 22, 1964. Speed build-up increments were evaluated up to 40 knots, the aircraft and nose landing gear were inspected, and tests were run at 50, 60, 70, and 80 knots. The 12.75 foot diameter emergency drag chute was deployed and released at 80 knots to demonstrate satisfactory operation of the chute deployment and rêlease mechanism.

The second high speed taxi test was also conducted on May 22, 1964. The aircraft was accelerated to 93 KIAS and the nose gear was lifted off. At 96 KIAS the main landing gear lifted off and a short flight at about 5 feet altitude was accomplished. The aircraft was lifted two more times during this run.

1. First flight, Test No. 1F, was completed May 25, 1964, see Figure 26. The following flight summary outlines the flight events This summary format will be used in describing the balance of flights during this reporting period.

a) Ship No.: XV-5A S/N:62-4506 Flight: 1F Date: May 25, 1964
Pilot: V. Schaeffer T.O. Time: 0935 PDT Flight Time: 20 Min.
T.O. Gross Weight: 10,500 lbs. C.G.: 29.0% MAC

b) Work Accomplished Prior to Flight
   1) Replaced engine fire bottle.
   2) Insulated both fire bottles to prevent inadvertent actuation,
   3) Replaced and calibrated instrumentation C.G. vertical accelerometer.

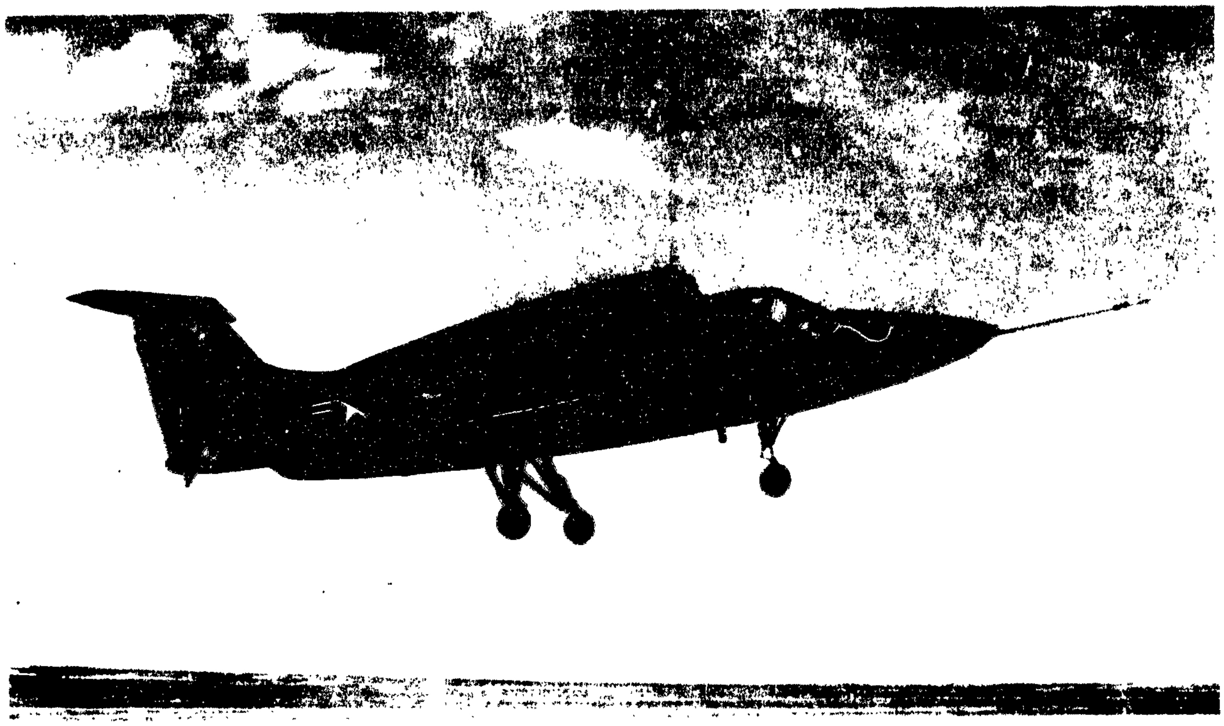


Figure 26. First Flight of XV-5A.

c) Test and Configuration

1) Low Speed CTOL Flight.

2) Aircraft in CTOL Configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed runway 05 with 30° trailing edge flaps.

2) With flaps remaining at 30°, climb to 8,000 ft.

3) Evaluate control response and sensitivity during low G maneuvering flight.

4) Determine longitudinal trim requirements at various speeds and power settings.

5) Determine aircraft landing characteristics during power approach maneuver at 5,000 ft.

6) Land on lakebed runway 05 using light braking.

7) Flight per card.

e) Flight Crabs

None

f) Comments

1) After an approximately 2,500 foot acceleration to 95 KIAS, the nose wheel was lifted off and the aircraft immediately became airborne. The aircraft was accelerated to 135 KIAS and a steady climb to 8,000 ft. was made at approximately 1,000 FPM.

2) During the climbout, some maneuvering was done and pilot reported excellent handling characteristics. Control forces were described as light at all conditions.

3) The aircraft was leveled off at 8,000 feet and several low G turns were made. Pilot commented that response of the aircraft is excellent and that control sensitivity is high. Lateral control stability was extremely good, the pilot noting that it is the best test he has flown in many years. Control harmony is also good, with no differences noted between lateral and longitudinal input response and feel. No indication of any roll-yaw coupling was evident.

4) Aircraft static longitudinal stability appears to be neutral below 115 KIAS and somewhat negative above 115 KIAS, exhibiting a nose down pitch moment with increased forward speed. Dynamic longitudinal inputs damped in about 1.5 cycles.

5) A simulated power approach landing was performed at 5,000 feet with 45° flaps. Pilot noted an increased pitch down moment with these flaps, as opposed to the 30° setting. The force buildup is not considered excessive and pilot noted no problem with the landing attitude handling.

6) A power on landing was made without incident on the lakebed. Touchdown occurred at about 95 KIAS. Light braking only was used to a full stop.

g) Instrumentation

PCM system tape transport malfunctioned prior to takeoff. Telemetry operated normally.

2. On May 26, 1964, Flight 2F was successfully completed. A single flight crab was filed, noting hydraulic leakage from the wheel brake reservoirs. This problem was corrected by providing larger reservoir expansion space.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 2F Date: May 26, 1964
Pilot: L. Everett T.O. Time: 0835 PDT Flight Time: 25 Min.
T.O. Gross Weight: 11,600 lbs. C.G.: 29.99% MAC

b) Work Accomplished Prior to Flight

1) Repaired damaged air conditioning ram air flapper valve .
2) Repaired malfunctioning PCM tape transport.
3) Calibrated R/H aileron position on PCM.

c) Test and Configuration

1) Low Speed CTOL Flight.
2) Aircraft in CTOL Configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed runway 23 with 30° trailing edge flaps.
2) Medium power climbout to 7,500 feet with 30° flaps.

3) Determine longitudinal trim requirements as a function of flap position, power setting and airspeed.

4) Determine static longitudinal stability during acceleration to 150 KIAS and deceleration to 110 KIAS from trim speed of 120 KIAS with flaps up.

5) Flight per card.

e) Flight Crabs

Hydraulic fluid noted leaking from wheel brake reservoirs in cockpit.

f) Comments

1) The takeoff was made from the lakebed at approximately 100 KIAS. Rotation and liftoff were simultaneous at this speed.

2) The climbout to 7,500 feet was uneventful. Pilot commented that the lateral control is quite sensitive and response is good.

3) The following trim requirement points were obtained:

(a) Trim at 150 KIAS with 0 flaps and power at that required to maintain level flight Fully extend flaps and maintain altitude. This resulted in the nose down pitching moment experienced on Flight 1F Pilot did not consider forces excessive for this condition.

(b) Trim at 135 KIAS with 45° flaps and power required for level flight. Reduce power to idle and maintain airspeed. The aircraft cannot be trimmed to hands off at this speed due to the large pitch down moment induced by the flaps. The reduction in power aggravates this condition but does not cause the aft stick loads to become excessive.

(c) Trim at 110 KIAS with 45° flaps and power for level flight. Increase power to maximum and maintain altitude. This again causes the nose down pitching moment to appear as a result of increased speed. The aircraft neutrally stable at the trim condition.

(d) Trim at 140 KIAS with 30° flaps and maximum power. Retract flaps to 0 and maintain rate of climb. In order to hold the rate of climb constant, the speed bled off and the aft stick force became lighter.

4) The static longitudinal stability check at 0 flaps disclosed definite positive stability. The pilot reported good handling qualities with the 0 flap setting. The aircraft speed was reduced to 110 KIAS only to keep from entering a possible stall area.

5) Landing was made on the lakebed with 45° flap. Final approach was made at 104 KIAS.

g) Instrumentation

PCM and telemetry were operated.

3. Flight 3F was completed May 27, 1964 to evaluate static and dynamic stability.

a) Ship No.: XV-5A S/N: 62-4506 Flight: 3F Date: May 27, 1964
Pilot: V. Schaeffer T.O. Time: 0845 PDT Flight Time: 35 Min.
T.O. Gross Weight: 11,000 lbs. C.G.: 29.06% MAC

b) Work Accomplished Prior to Flight

1) Made provisions for rapid removal of external air conditioning duct doors.

2) Replaced and calibrated instrumentation airspeed and altitude transducers.

3) Calibrated R/H aileron position on PCM.

4) Installed standpipes on wheel brake reservoirs to provide increased fluid expansion capability.

c) Test and Configuration

1) Low Speed Stability Investigation.

2) Aircraft in CTOL Configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed runway 23 with 30° trailing edge flaps.

2) Climb to 7,500 feet with 0 flaps.

3) Short period dynamic longitudinal stability.

4) Long period dynamic longitudinal stability.

5) Landing on lakebed runway 23 with 45° flaps.

6) Flight per card.

e) Flight Crabs

None

f) Comments

1) Takeoff was uneventful. Liftoff was at 95 KIAS. Flaps were retracted to 0 at 130 KIAS and climbout was made to 7,500 feet. Pilot reported that aircraft felt very solid and easy to fly with the flaps up.

2) The short period longitudinal stability with 0 flaps was checked by means of stick hits at 130 KIAS. Aircraft response was deadbeat in both directions, indicating good positive stability.

3) The phugoid mode (long period) stability check disclosed positive stability. With stick release at either 110 KIAS or 150 KIAS after trimming at 130 KIAS, the aircraft returns to trim speed in approximately 1.5 cycles. Pilot noted that there is a certain degree of difficulty in trimming up the aircraft precisely. The trim speed after maneuvering does not agree with that stabilized on prior to the point.

4) An uneventful landing was made on the lakebed.

g) Instrumentation

The PCM and telemetry were operated. A belt on the PCM tape transport slipped off during the flight, thus precluding the acquisition of more than 75% of the anticipated data.

4. Flight Release No. 4F was to determine low speed handling qualities. Phugoid, static lateral-directional stability, static longitudinal stability and longitudinal trim changes were evaluated in the 110 KIAS to 150 KIAS range.

a) Ship No.: XV-5A S/N: 62-4506 Flight: 4F Date: May 27, 1964
   Pilot: L. Everett T.O. Time: 1345 PDT Flight Time: 40 Min.
   T.O. Gross Weight: 11,150 lbs. C.G.: 29.3% MAC

b) Work Accomplished Prior to Flight
   1) Replaced wheel hub bearings in PCM tape transport.
   2) Replaced R/H main wheel tire.
   3) Conducted full throw control surface calibration on PCM.

c) Test and Configuration
   1) Low Speed Stability Investigation.
   2) Aircraft in CTOL Configuration.

d) Flight Plan and Actual Flight
   1) Takeoff on lakebed runway 23 with 30° trailing edge flaps.
   2) Climb to 7,500 feet with 0 flaps.
   3) Long period dynamic longitudinal stability with 0 flaps.
   4) Static lateral and directional control response and sensitivity check with 0 flaps.
   5) Static lateral-directional stability check with 0 flaps.
   6) Static longitudinal stability check with 30° flaps.
   7) Longitudinal trim requirements with configuration change.
   8) Landing on lakebed runway 23 with 22° flaps.
   9) Flight per card.

e) Flight Crabs
   None

f) Comments
   1) Takeoff and climbout was uneventful.
   2) The long period longitudinal dynamic check was made to attain the data lost on Flight 3F due to the loss of PCM tape. The same comments apply.

3) The lateral and directional control checks indicated good sensitivity and aircraft response. Aileron and rudder S turns were used to accomplish this test.

4) Steady state sideslips to 5 degrees of sideslip disclosed positive static lateral-directional stability. No indication of any control softening was noted. Rudder deflections were made incrementally initially to determine aircraft response, and then in a smooth motion for data purposes.

5) The static longitudinal stability check with 30° flaps disclosed that a slight nose down moment is present with increased speeds. This is much less than that encountered with full down flaps.

6) The longitudinal trim requirement checks were repeated from Flight 2F for data purposes. Comments were as noted on Flight 2F.

7) Landing on lakebed was without incident with 22° flaps. This flap setting was chosen due to a somewhat turbulent condition existing at the time, and the improved handling qualities of the airplane at the higher flap settings.

g) Instrumentation

PCM and telemetry were operated.

5. Test No. 5F on June 3, 1964 was to investigate stall approaches with flaps up, power on and power off.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 5F Date: June 3, 1964
Pilot: V. Schaeffer T.O. Time: 0845 PDT Flight Time: 35 Min.
T.O. Gross Weight: 10,932 lbs. C.G.: 29.5% MAC

b) Work Accomplished Prior to Flight

1) Installed ballast tray and 100 lbs. of ballast in aft fuselage.
2) Installed spin chute in aircraft.
3) Conducted ground run 4.01G to check out spin chute deployment.
4) Replaced wheel brake components as required.
5) Bled and adjusted wheel brakes.

6) Calibrated PCM lateral, longitudinal stick force and rudder pedal force.

7) Activated PCM trailing edge flap position.

8) Calibrated PCM outside air temperature.

c) Test and Configuration

1) Aircraft stall approach investigation.

2) Low speed stability investigation.

3) Aircraft in CTOL configuration.

4) Landing gear fixed in extended CTOL position.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed runway 23 with 15° trailing edge flaps.

2) Climb to 5,000 feet with 0 flaps.

3) Static longitudinal stability check at 5,000 feet with 0 flaps and aft center of gravity.

4) Climb to 15,000 feet with 0 flaps.

5) Perform power-on and power-off stall approaches at 15,000 feet with 0 flaps with forward C.G.

6) Static longitudinal stability check at 15,000 feet with 0 flaps and forward C.G.

7) Static longitudinal stability check at 15,000 feet with 30° flaps and forward C.G.

8) Flight per card.

e) Flight Crabs

None

f) Comments

1) Liftoff was made at approximately 98 KIAS with 15° trailing edge flaps. Pilot commented that takeoff was quite comfortable at this condition.

2) The static longitudinal stability points were run to obtain the effect on the stability of changes in C.G. position. Pilot comment indicates that the C.G. location has a relatively small, if any, effect on the basic aircraft stability, no tendency being

observed for the aircraft to deviate from any speed offset. The crossover point from negative or neutral stability at high flap settings to positive stability at low flap settings appears to occur at about 20° flaps.

3) Several stall approaches were made with power on and off at full up flaps. The stalls were approached by a slow decrease in airspeed by the use of aft stick. Aircraft controllability was constantly monitored by the pilot with control inputs. The stall approach characteristics were described as classical by the pilot, a slight buffet occurring repeatedly at 24° angle of attack and the buffeting increasing with further increases in alpha. A slight lateral wallowing occurs at 25° alpha and the nose falls through easily at nearly 26° alpha. No loss of control on any axis was noted at any time by the pilot. Very little difference was noted between the two power settings checked.

4) Landing was accomplished on the lakebed with 15° flaps. This flap setting appears to be the best yet tried for pilot comfort and reasonable speeds.

g) Instrumentation

PCM and telemetry operated normally.

6. The purpose of Flight 6F was to test static longitudinal stability with 30° flaps, stall approaches at 15°, 30°, and 45° flaps, and to perform a preconversion configuration check.

a) Ship No.: XV-5A S/N: 62-4506 Flight No: 6F Date: June 3, 1964
Pilot: L. Everett T.O. Time: 1420 PDT Flight Time: 35 Min.
T.O. Gross Weight: 11,002 lbs. C.G.: 244.5% MAC

b) Work Accomplished Prior to Flight

Completed in-between flight inspection on aircraft and instrumentation.

c) Test and Configuration

1) Aircraft stall approach investigation.

observed for the aircraft to deviate from any speed offset. The crossover point from negative or neutral stability at high flap settings to positive stability at low flap settings appears to occur at about 20° flaps.

3) Several stall approaches were made with power on and off at full up flaps. The stalls were approached by a slow decrease in airspeed by the use of aft stick. Aircraft controllability was constantly monitored by the pilot with control inputs. The stall approach characteristics were described as classical by the pilot, a slight buffet occurring repeatedly at 24° angle of attack and the buffeting increasing with further increases in alpha. A slight lateral wallowing occurs at 25° alpha and the nose falls through easily at nearly 26° alpha. No loss of control on any axis was noted at any time by the pilot. Very little difference was noted between the two power settings checked.

4) Landing was accomplished on the lakebed with 15° flaps. This flap setting appears to be the best yet tried for pilot comfort and reasonable speeds.

g) Instrumentation

PCM and telemetry operated normally.

6. The purpose of Flight 6F was to test static longitudinal stability with 30° flaps, stall approaches at 15°, 30°, and 45° flaps, and to perform a preconversion configuration check.

a) Ship No.: XV-5A S/N: 62-4506 Flight No: 6F Date: June 3, 1964
Pilot: L. Everett T.O. Time: 1420 PDT Flight Time: 35 Min.
T.O. Gross Weight: 11,002 lbs. C.G.: 244.5% MAC

b) Work Accomplished Prior to Flight

Completed in-between flight inspection on aircraft and instrumentation.

c) Test and Configuration

1) Aircraft stall approach investigation.

2) Low speed stability investigation.

3) Aircraft in CTOL configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed runway 23 with 20° trailing edge flaps.

2) Climbout to 15,000 feet with 0 flaps.

3) Static longitudinal stability check at 15,000 feet with 30° flaps and forward C.G.

4) Power on stall approaches at 15,000 feet with 15° flaps.

5) Power on stall approaches at 15,000 feet with 30° flaps.

6) Power on stall approaches at 15,000 feet with 45° flaps.

7) Preconversion configuration check at 15,000 feet with 45° flaps.

8) Landing on lakebed runway 23 with 10° flaps.

9) Flight per card.

e) Flight Crabs

None

f) Comments

1) Liftoff from lakebed occurred at about 96 KIAS with 20° flaps. Pilot commented that takeoff was comfortable.

2) The aircraft static longitudinal stability appears to be neutral to negative at the 30° flap setting. The nose down pitching moment increases with airspeed.

3) The stall approaches were performed in the same manner as on Flight 5F. Nearly identical results were obtained as on that flight Very little difference, other than slightly heavier stick forces on the flap down runs, was noted between the different stall approaches. Onset of buffet occurs at between 22° and 23° alpha, wing wallowing at 25° alpha, and a gentle fall through of the nose at nearly 26° alpha. The aircraft recovers immediately by reduction of aft stick force. No loss of any control was encountered, even at the maximum angles checked.

4) A check of the aircraft reaction to the preconversion mode configuration was made successfully. In this mode, the pitch fan inlet louvers are open, the pitch fan exit doors are open and respond to longitudinal stick inputs, and the wing fan exit louvers are vectored to a 45° position. The changeover into this mode was made at 45° flaps. The pilot did not perform any specific stability checks in this configuration, but did report that the aircraft handles well and that most of the pitch down moment associated with the 45° flap setting appears to disappear when the preconversion mode is selected.

5) Landing was without incident on the lakebed with 10° flap setting. Pilot reported that this configuration is comfortable.

g) Instrumentation

PCM, telemetry and photo panel operated normally.

Time history plots are shown for Flight 6F in Figures 27, 28, and 29. Figure 28 shows trim and control inputs plotted against time as the pitch fan doors open. Figure 28 shows control and trim imputs and airspeed versus time for the 20° flap takeoff for Flight 6F. Figure 29 presents the landing with 10° flaps for Flight 6F.

7. Flight 7F investigated preconversion handling characteristics and stalls.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 7F Date: June 4, 1964
Pilot: V. Schaeffer T.O. Time: 0815 PDT Flight Time: 40 Min.
T.O. Gross Weight: 11,032 lbs. C.G.: 26.8% MAC

b) Work Accomplished Prior to Flight

1) Removed inlet guide vanes from wing fans for use on #1 aircraft in wind tunnel.

2) Calibrated PCM trailing edge flap position .

c) Test and Configuration

1) Aircraft stall approach investigation.

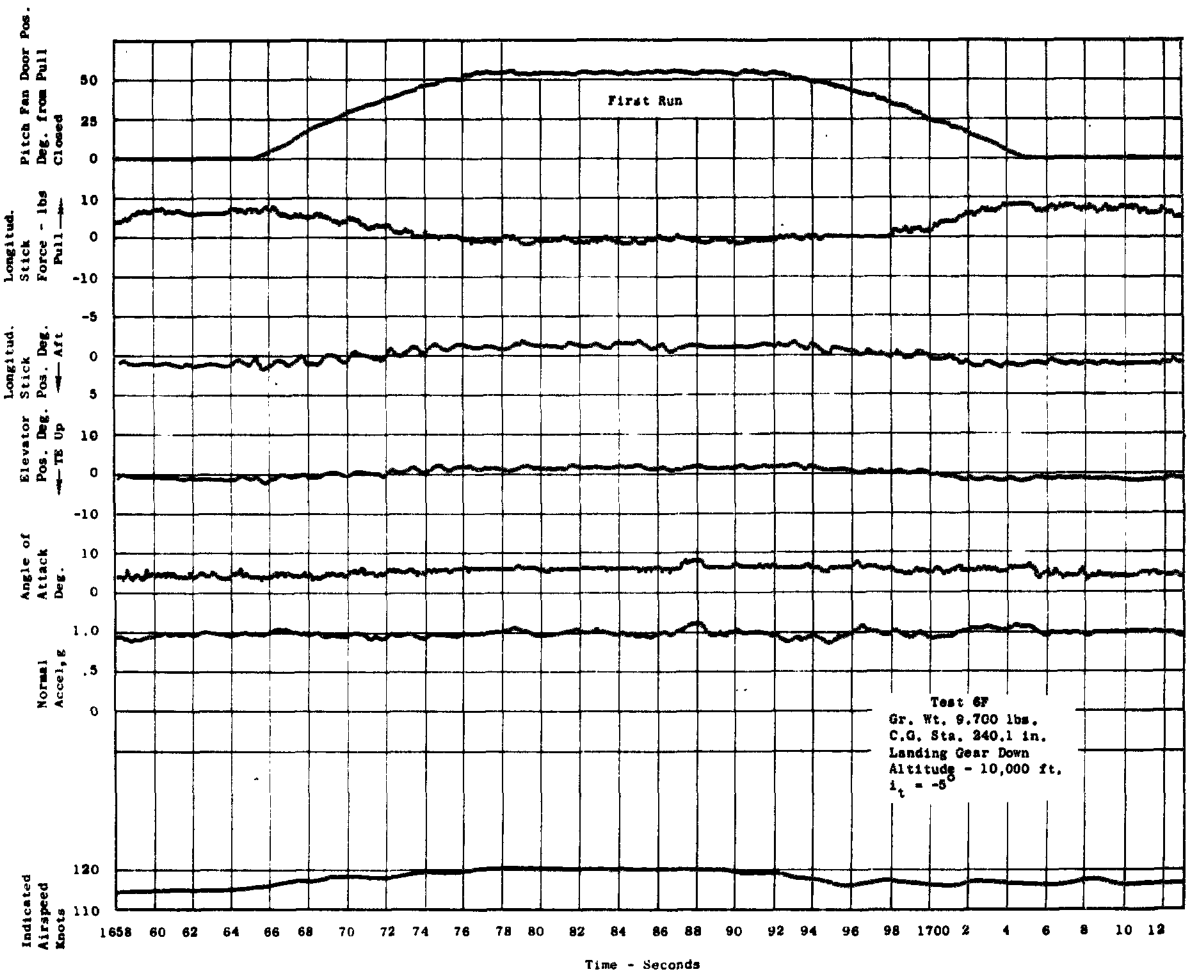


Figure 27. XV-5A #2 Time History of Aircraft Configuration Change from Full Flaps (CTOL) to Pre-Conversion Configuration.

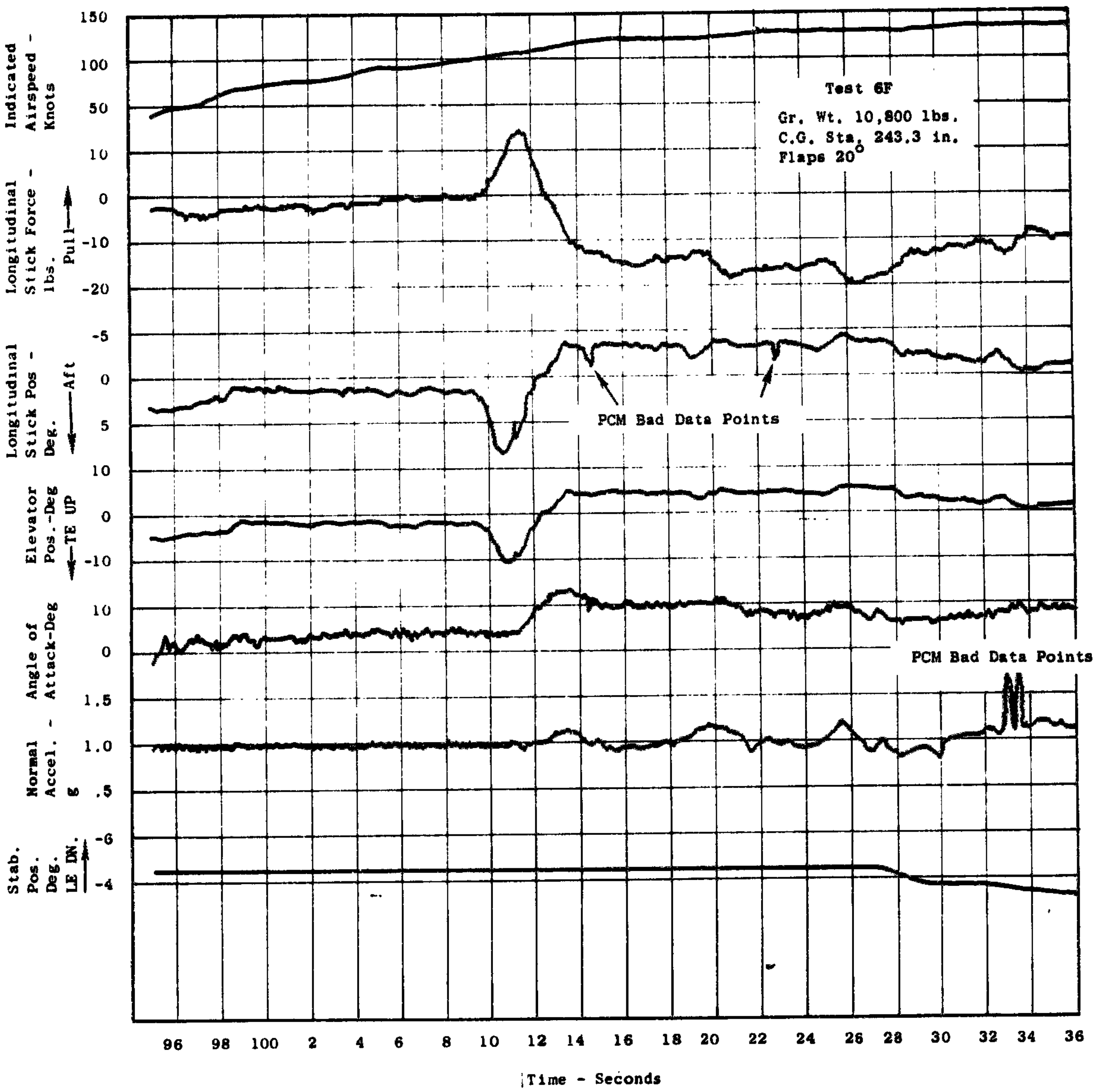


Figure 28. XV-5A #2 Time History of Take-off.

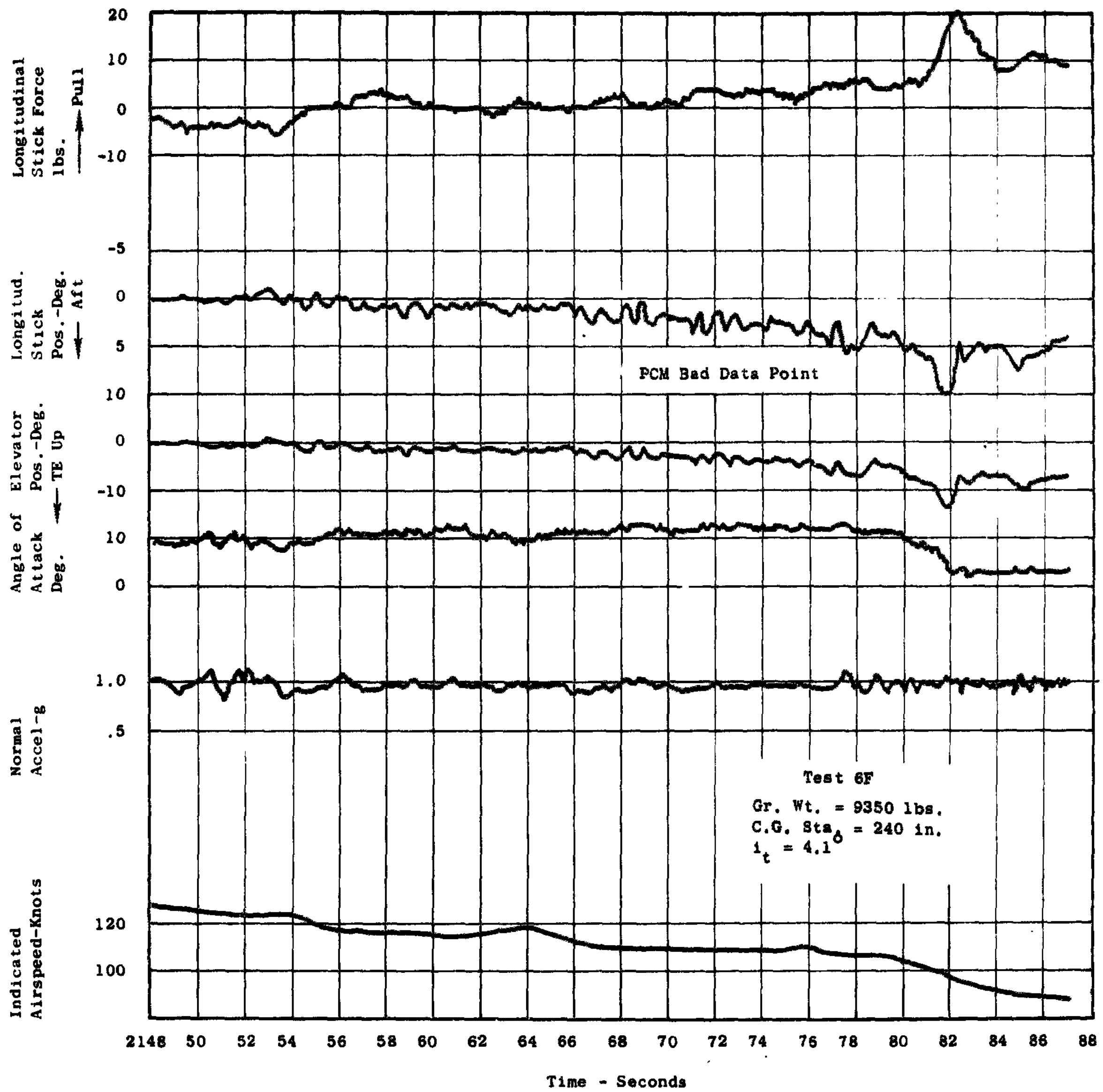


Figure 29. XV-5A #2 Time History of Landing, 10° Flaps.

2) Low speed stability investigation.

3) Aircraft in CTOL configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed with 0 flaps.

2) Climbout to 15,000 feet with 0 flaps.

3) Power off stall approaches at 15,000 feet with 45° flaps.

4) Preconversion configuration stability checks at 15,000 feet with 45° flaps at 110 KIAS - 120 KIAS.

5) Preconversion configuration - power on stall approaches at 15,000 feet with 45° flaps.

6) Short period dynamic longitudinal stability checks at 15,000 feet with flaps 0 in CTOL mode at 130 KIAS.

7) Static - dynamic lateral-directional stability checks at 15,000 feet with flaps 45° in CTOL mode at 120 - 150 KIAS.

8) Landing on lakebed with 0 flaps.

9) Flight per card.

e) Flight Crabs

None

f) Comments

1) Takeoff was made with 0 flaps. Liftoff occurred at 105 KIAS. This condition was slightly uncomfortable due to the higher speed and the fact that the airplane did not fly itself off the runway as readily as it does with flaps down. The pilot had to rotate the aircraft to achieve liftoff. A second factor contributing to this effect is the forward C.G. dictated by other test requirements.

2) The power off stall approach with 45° flaps and the preconversion stall approach yielded nearly identical angle/attack version approach; the aircraft longitudinal static stability appears neutral as the stick forces were very light and the alpha could be set and retained without the use of any appreciable stick

2) Low speed stability investigation.

3) Aircraft in CTOL configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed with 0 flaps.

2) Climbout to 15,000 feet with 0 flaps.

3) Power off stall approaches at 15,000 feet with 45° flaps.

4) Preconversion configuration stability checks at 15,000 feet with 45° flaps at 110 KIAS - 120 KIAS.

5) Preconversion configuration - power on stall approaches at 15,000 feet with 45° flaps.

6) Short period dynamic longitudinal stability checks at 15,000 feet with flaps 0 in CTOL mode at 130 KIAS.

7) Static - dynamic lateral-directional stability checks at 15,000 feet with flaps 45° in CTOL mode at 120 - 150 KIAS.

8) Landing on lakebed with 0 flaps.

9) Flight per card.

e) Flight Crabs

None

f) Comments

1) Takeoff was made with 0 flaps. Liftoff occurred at 105 KIAS. This condition was slightly uncomfortable due to the higher speed and the fact that the airplane did not fly itself off the runway as readily as it does with flaps down. The pilot had to rotate the aircraft to achieve liftoff. A second factor contributing to this effect is the forward C.G. dictated by other test requirements.

2) The power off stall approach with 45° flaps and the preconversion stall approach yielded nearly identical angle/attack version approach; the aircraft longitudinal static stability appears neutral as the stick forces were very light and the alpha could be set and retained without the use of any appreciable stick

force. The aircraft would respond well to stick inputs and no problem is foreseen with low speed flight in the preconversion configuration.

3) Short period dynamic longitudinal checks, light aileron and rudder S turns, and steady state sideslips were performed in the preconversion mode with favorable comments throughout. Stick hit response is deadbeat at 115 KIAS.

4) The CTOL mode stability checks were for the purpose of acquiring lost data and also to probe more deeply into the higher angle steady state sideslips and abrupt rudder release response Sideslips were made up to 9°, at which time stall warning buffet occurred. No aileron or rudder control softening was noted. The abrupt rudder releases from 5° sideslip damped in 1.5-2 cycles.

5) Landing was made on the lakebed with 0 flaps at 110 KIAS. This speed is high and somewhat uncomfortable as aircraft control is somewhat less responsive than with flaps down.

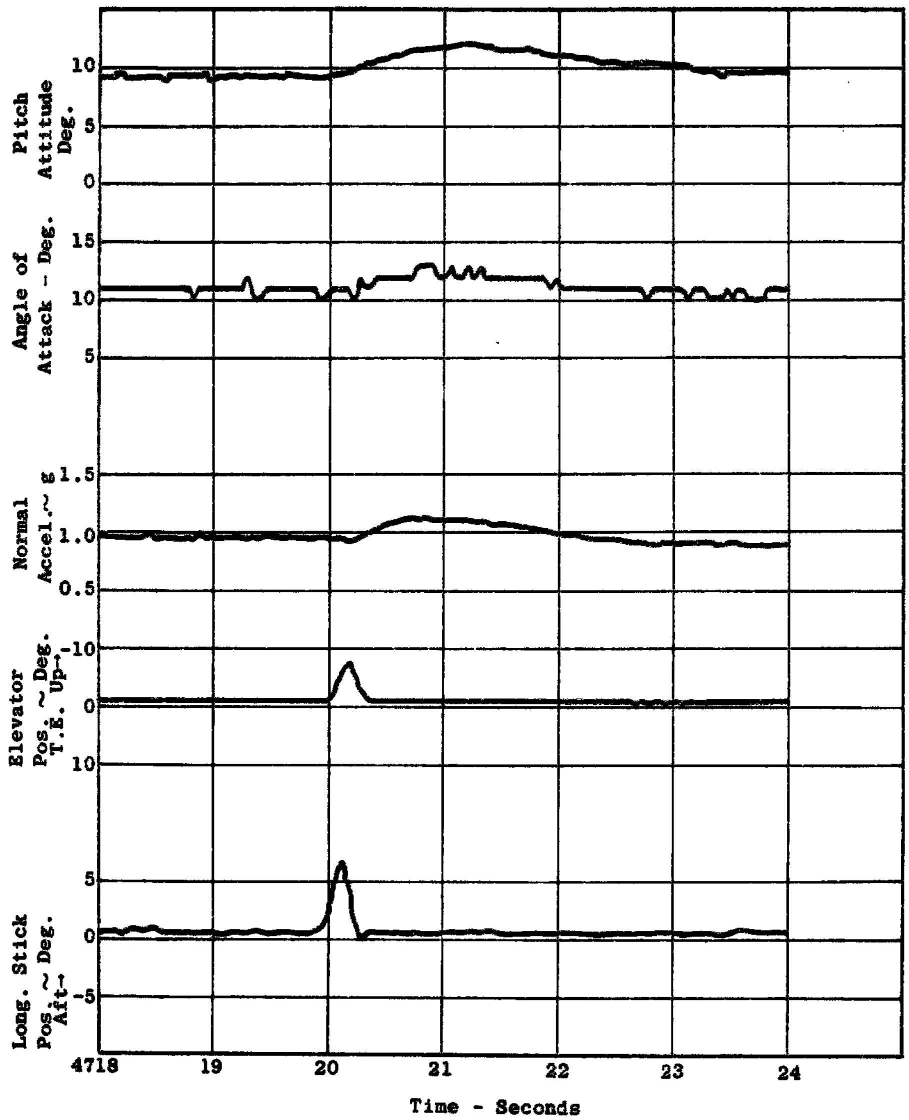
g) Instrumentation

PCM, telemetry and photo panel operated normally.

Figures 30, 31, 32, and 33 are plots taken during Flight 7F. Figure 30 shows the dynamic longitudinal stability characteristics. Dynamic tests show "dead beat" results. Static directional stability characteristics are shown in Figure 31. Directional stability is positive up to 9° of sideslip. Figures 32 and 33 show time history plots of stall approaches. Conclusions included that preconversion flight characteristics are similar to full flap characteristics through the stall.

8. Flight 8F conducted on June 5, 1964, completed the first series of low speed conventional mode flight testing. The purpose was airspeed calibration.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 8F Date: June 5, 1964
Pilot: L. Everett T.O. Time: 0635 PDT Flight Time: 40 Min
T.O. Gross Weight: 11,047 lbs. C.G.: 29.8% MAC



Test 7F

Gr. Wt. 9,675 Lbs.
C.G. Sta. 240.2 In.
Landing Gear Down
Altitude 15,000 Ft.
0° Flaps - 128 KIAS
i_t = -2.7°

Figure 30. XV-5A #2 - Dynamic Longitudinal Stability - Aft Stick Hit.

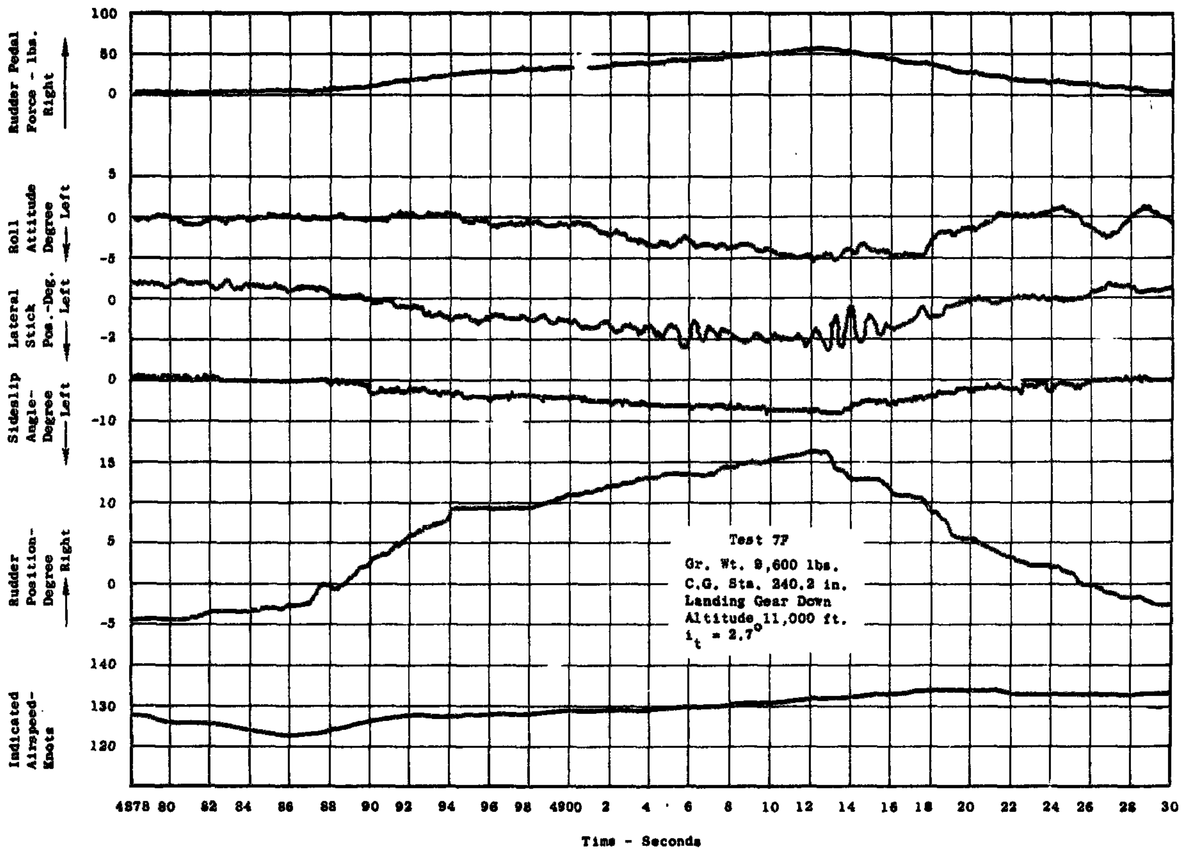


Figure 31. XV-5A #2 Static Directional Stability, 0^o Flaps.

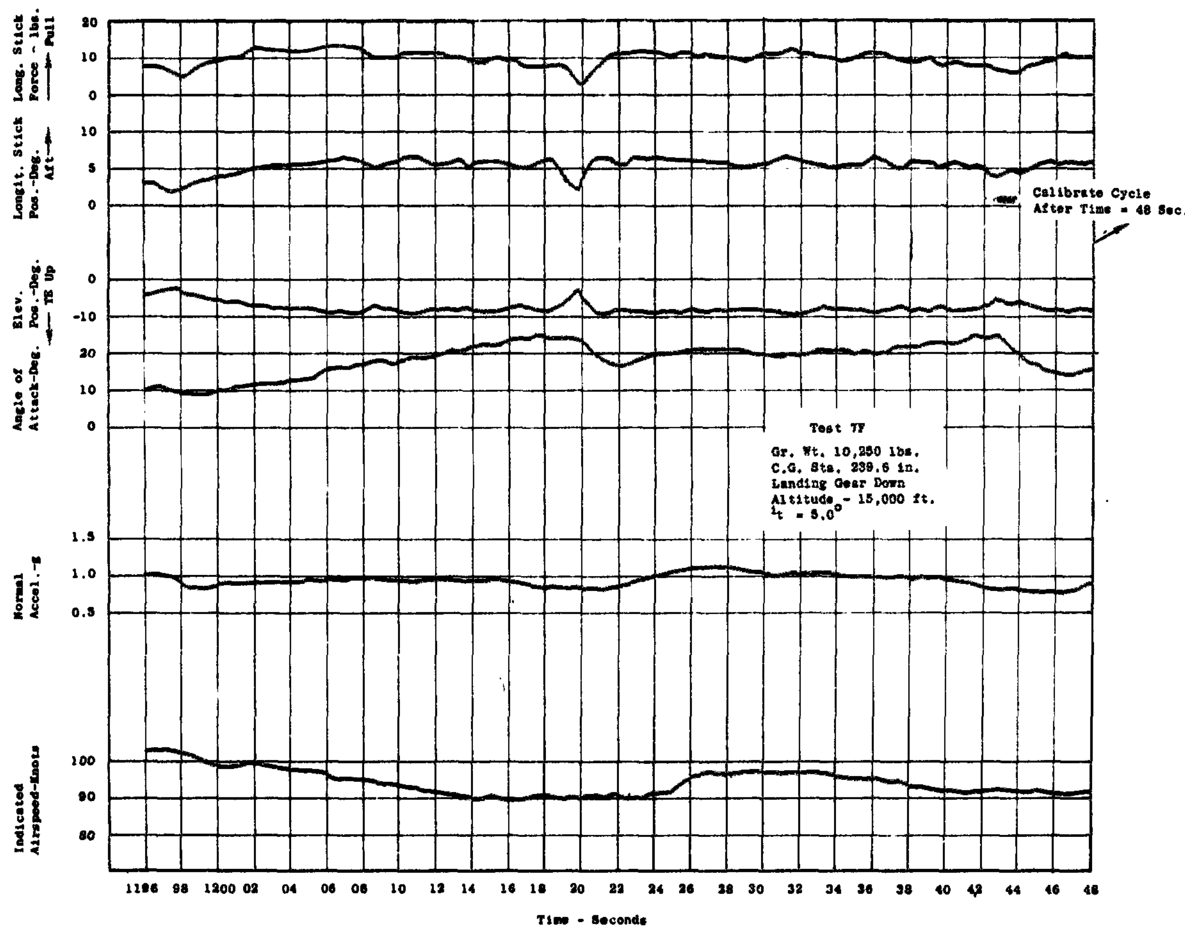


Figure 32. XV-5A #2 Time History of Approach to Stall, 45° Flaps, Idle Power.

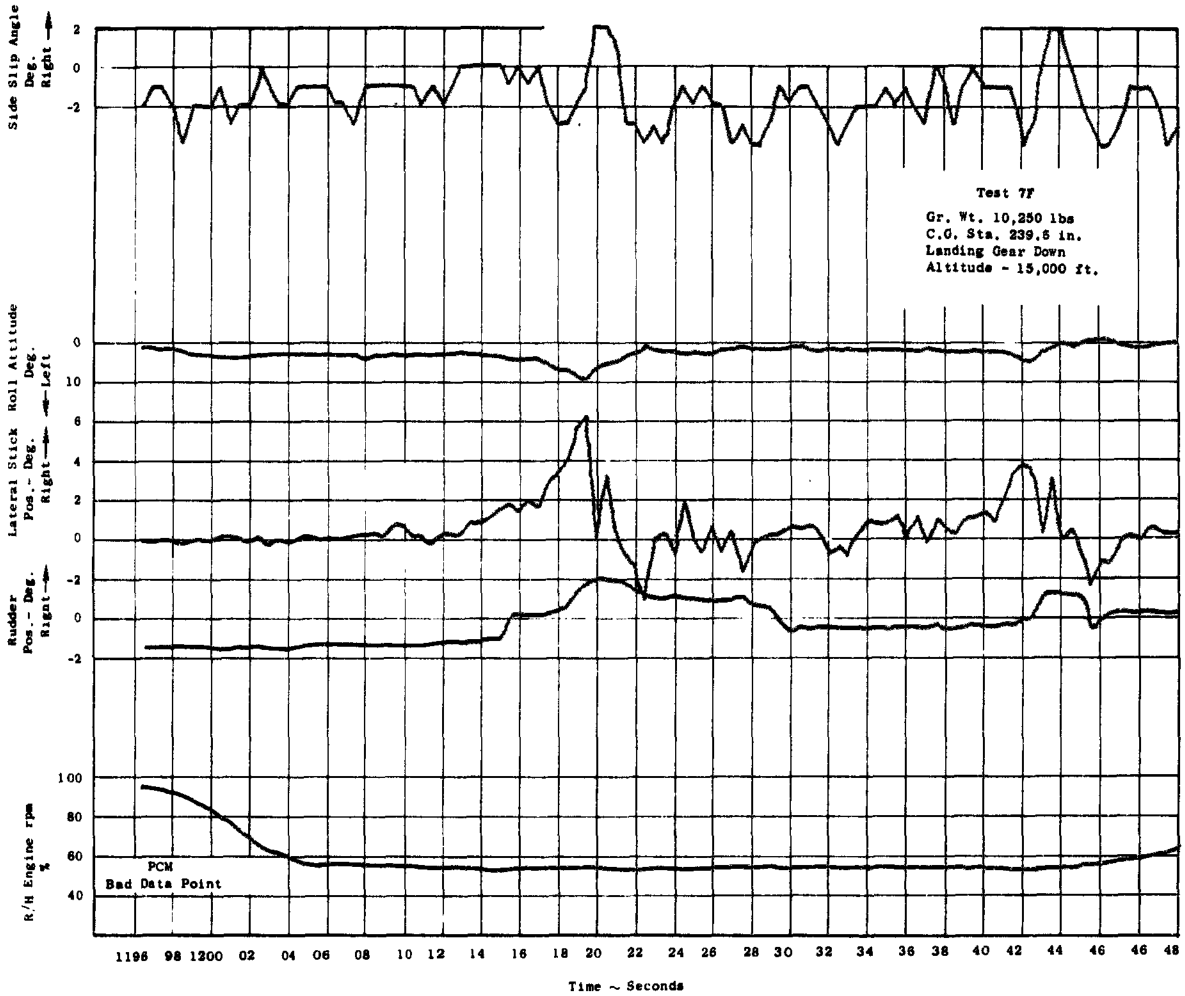


Figure 33. XV-5A #2 Time History of Approach to Stall 45°, Flaps - Idle Power.

b) Work Accomplished Prior to Flight

Repaired photo panel correlation counter.

c) Test and Configuration

1) Airspeed position error calibration. Pacer and flyby methods.

2) Aircraft in CTOL configuration.

d) Flight Plan and Actual Flight

1) Takeoff on lakebed with flaps at 25°.

2) Climbout to 5,000 feet with 0 flaps.

3) Airspeed pacer points on T-37 pace aircraft at 5,000 feet at 160, 150, 140, 130, 120, 110, 100 and 93 KIAS.

4) Tower flyby points at 120, 135 and 150 KIAS.

5) Landing on lakebed with flaps at 25°.

6) Flight per card.

e) Flight Crabs

None

f) Comments

1) Takeoff was from lakebed with flaps at 25°. The stick was pulled aft at about 80 KIAS and the aircraft nose lifted at 95 KIAS. Main wheel liftoff was immediate.

2) During the climbout, the pilot noted that with the throttles locked together, a fairly large disparity exists between engine speeds. No adverse effect on aircraft performance was reported. An investigation of this condition will be made prior to the next flight.

3) The airspeed calibration points were performed per the flight card. All points were considered reasonably stable and valid for data purposes.

4) The landing was made with flaps at 25°. The flareout was made with power off, touchdown occurring at 100 KIAS. No adverse comments were made.

g) Instrumentation

PCM, telemetry and photo panel operated normally.

On June 9, 1964, Aircraft Number 2 went into layup for modification of the wing fans and installation of new actuators to increase roll control power for hovering. During the layup, the cradle used to mount the XV-5A to the A.F.F.T.C. VTOL thrust stand was installed, and thrust stand calibrations were started.

The rework in Aircraft Number 2 was completed on June 30, 1964. The major items of rework included:

1) Installation of modified wing fan turning vanes.
2) Stiffening of the wing fan struts.
3) Installation of new wing fan actuator brackets.
4) Installation of new and reworked wing fan louver pushrods.
5) Installation of new exit louver servo actuators.
6) Installation of new bell cranks in the mixer box to increase roll commanded output.
7) Installation of stiffened louvers.
8) Installation of new wing fan servo actuator fairings.

The aircraft was moved to the tie-down area on June 30, 1964 for engine runs. Numerous delays were encountered during this series of runs:

1) Structural overheat warning light came on after short periods of engine operation.
2) Several J-85 compressor stalls were encountered.

The reference resistor of the structural overheat warning system was changed after temperature surveys indicated that the warnings were premature. General Electric started work to eliminate compressor stalls, and engine adjustments were made to increase the stall margin.

During the week of July 6-11, 1964, Aircraft Number 2 was installed on the VTOL thrust stand. Control power in all axes was checked and lift and thrust were measured. Compressor stall checks were made with no stalls occurring until the inlet de-icer switch was operated. The engine was shut down, but could not be

motored because it had seized. Investigation revealed a thrust bearing failure had allowed the rotating member of the compressor to shift forward and collide with the fixed blades. The engine was replaced, and the aircraft was prepared for hover flight. Figure 34 shows the airplane mounted on the thrust stand.

NASA-Ames thrust stand and wind tunnel data were reduced and compared with Edwards Air Force Base thrust stand data. With the aircraft modifications completed, Ship Number 2 was preflighted on July 15, 1964 to accomplish the initial hovering flight.

9. Flight 9F, on July 16, 1964, was the first hover attempt since March 31, 1964, when the first attempt was aborted due to low roll control power. Figure 35 shows the XV-5A during the first hover flight.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 9F Date: July 16, 1964
   Pilot: L. Everett T.O. Time: 1000 PDT Flight Time: 25 Min.
   T.O. Gross Weight: 10,330 lbs. C.G.: 239.94 in.

b) Work Accomplished Prior to Flight
   1) Modified aircraft for new wing fan louver actuators.
   2) Reworked mixer box for increased louver stagger control with lateral stick displacement.
   3) Installed louvers with increased stiffness.
   4) Installed Mod. II wing fan inlet guide vanes.
   5) Reworked horizontal stabilizer to increase stiffness.

c) Test and Configuration
   1) VTOL hover.
   2) Aircraft in VTOL Configuration.
   3) Landing gear fixed in extended VTOL position.

d) Flight Plan and Actual Flight
   1) Taxi to hot gun line in CTOL mode.
   2) Convert to VTOL mode.
   3) Auto stab functional checkout.
   4) VTOL hover at 5-6 feet altitude.
   5) Flight per card.

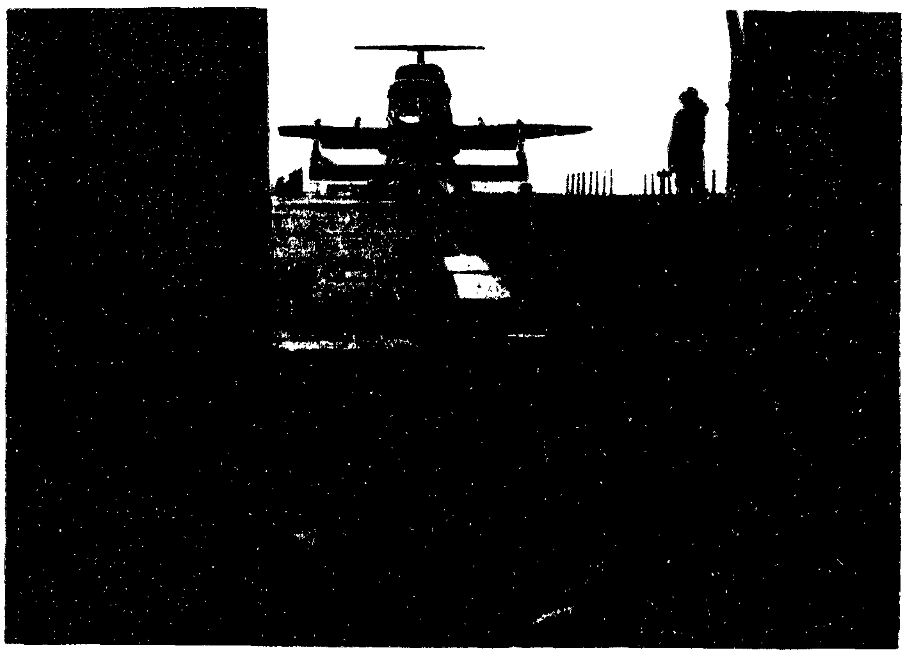


Figure 34. XV-5A on Edwards Vertical Thrust Stand.

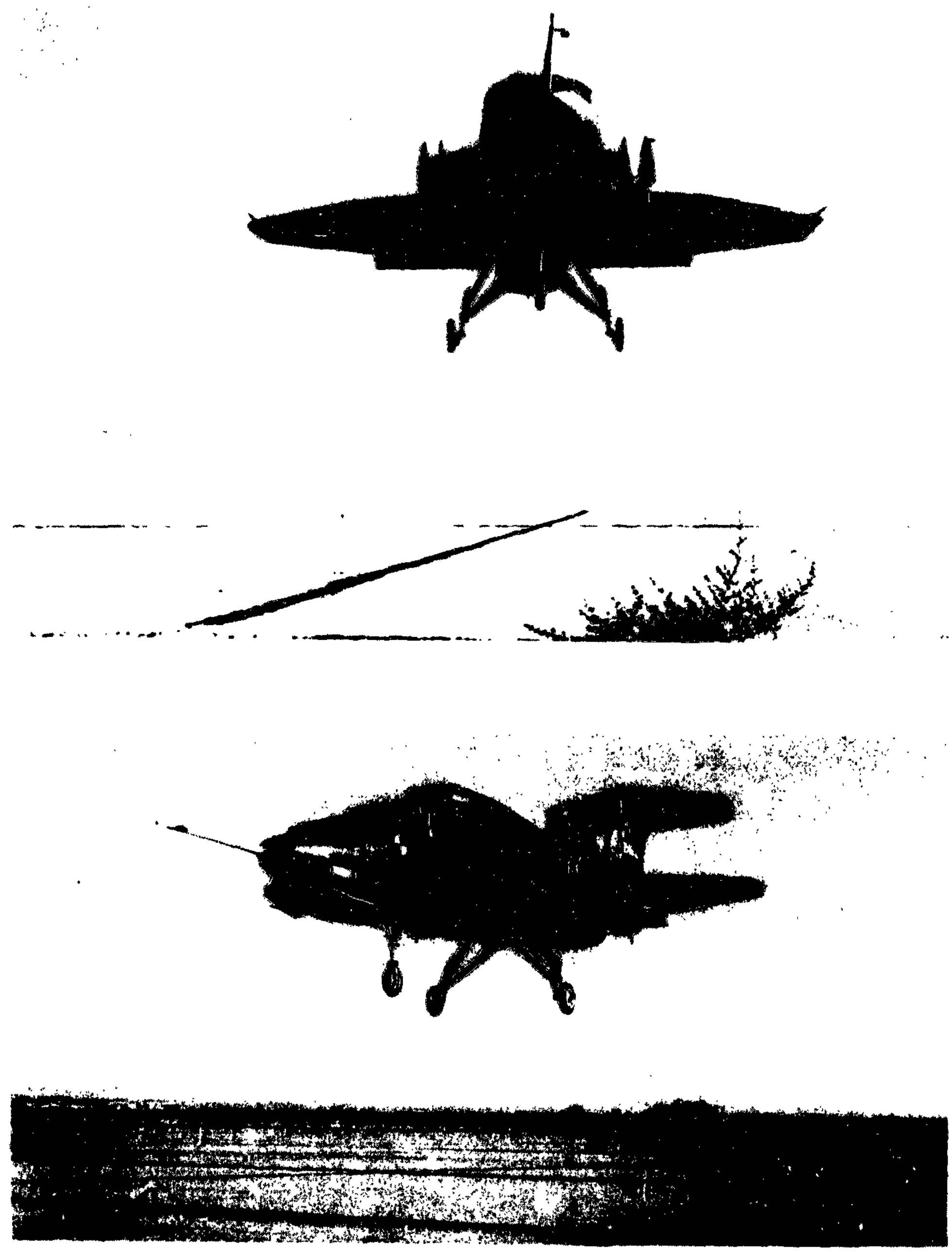


Figure 35. XV-5A During Hovering Test Flights.

e) Flight Crabs

VTOL roll trim indicator inoperative.

f) Comments

1) The engines were started at the hangar, the aircraft was taxied in CTOL mode to the hot gun line, the conversion was made to VTOL and several auto stab and taxi checks were made without incident.

2) Prior to the first hover attempt, a malfunction developed in the instrumentation system, necessitating a shutdown while the repair was made.

3) After engine restarts, the aircraft was again converted to VTOL mode and the hover attempts begun. Ambient temperature was 82°F and winds 2-4 knots. The first hover attempts were made downwind.

4) As power was increased, pilot noted the buildup of positive control about all axes. The initial liftoff resulted in the aircraft bouncing alternately on all 3 gears, and a resultant over control by the pilot. The second attempt was initiated with the nose wheel lifted first, and resulted in hover at approximately 4-6 inches, but this was upset by changes in roll attitude, which were amplified by landing gear reaction with the ground. The third attempt resulted in the same landing gear upsets at small vertical displacements.

5) On the fourth attempt, the aircraft was lifted vertically to a height of approximately 5 feet and held stationary over the ground for approximately 25 seconds. The descent was well controlled and the touchdown was very gentle.

6) The pilot commented that excellent control was felt about all axes and once airborne, practically no control inputs were required in the pitch and yaw axes. The roll control was extremely powerful and required only small stick displacements to maintain attitude.

g) Instrumentation

PCM, telemetry and photo panel were operated.

10. Flight 10F was performed to continue hovering control characteristics. Compressor stall was experienced during a landing.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 10F Date: July 17, 1964
Pilot: L. Everett T.O. Time: 0625 PDT Flight Time: 5 Min.
T.O. Gross Weight: 10,200 lbs. C.G.: 239.94 in.

b) Work Accomplished Prior to Flight
   1) Repaired cracked skin in vicinity of telemetry antenna.
   2) Repaired instrumentation tape transport "No Record" circuitry.

c) Test and Configuration
   1) VTOL hover.
   2) Determine aircraft response to small control inputs in hover.
   3) Aircraft in VTOL configuration.
   4) Landing gear fixed in extended VTOL position.

d) Flight Plan and Actual Flight
   1) Taxi to hot gun line in CTOL mode.
   2) Convert to VTOL mode.
   3) Auto stab functional checkout.
   4) VTOL hover at 5-6 feet altitude.
   5) Apply slight control inputs and determine aircraft response.
   6) Flight per card.

e) Flight Crabs
   1) VTOL roll trim indicator inoperative.
   2) Compressor stall on R/H engine immediately subsequent to landing.

f) Comments
   1) Engine starts were at the hangar. The aircraft was then taxied to the hot gun line in CTOL mode, a conversion to VTOL was made, and several auto stab checkouts were conducted.

2) Liftoff to hover was made without incident into a 2-5 MPH wind at 68°F ambient temperature. No pitch or yaw inputs and only slight lateral inputs were required to maintain attitude. Lift-off technique appears to be as follows:

   (a) RPM to approximately 99% with collective in lower quadrant.

   (b) Lift nose off the ground with aft stick.

   (c) Lift main gear off with collective control and climb out of ground effect without hesitation. Ground effect appears to be 4-5 feet deep.

3) Slight yaw inputs were applied while hovering. Aircraft response and arresting capability were good.

4) Small lateral stick deflections were made for low velocity lateral translations. Aircraft response again appears good.

5) The airplane was airborne for approximately 45 seconds. A gentle touchdown was made using collective control only at 99% RPM.

6) Immediately following touchdown, with the collective control in lower quadrant, a compressor stall was encountered on the R/H engine. The engine was recovered without difficulty but further testing was cancelled pending an investigation of the stall problem.

g) Instrumentation

PCM, telemetry and photo panel were operated.

Due to the compressor stall experienced on Flight 10F, both engines were reset (RPM increased and EGT reset) to provide a greater stall margin. The engines were run in the VTOL mode in the tie-down area, and rapid throttle bursts and cuts were made without inducing compressor stalls. It was felt that the changes made to the engines would provide sufficient stall margin to allow resumption of hover flights.

11. Flight 11F, on July 23, 1964, was completed with no stalls at all.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 11F Date: July 23, 1964
   Pilot: L. Everett T.O. Time: 0645 PDT Flight Time: 15 Min.
   T.O. Gross Weight: 10,200 lbs. C.G.: 239.94 in.

b) Work Accomplished Prior to Flight
   1) Replaced all wing fan louver actuators.
   2) Completed VTOL tie-down run 10.01G to determine engine data relative to compressor stall problem and to determine effect of single hydraulic system operation on the wing fan louvers.
   3) Calibrated wing fan louver positions, C.G. accelerometers and engine and wing fan RPM's on PCM.

c) Test and Configuration
   1) VTOL hover.
   2) Aircraft control response to moderate pilot inputs.
   3) Landing gear fixed in extended VTOL position.

d) Flight Plan and Actual Flight
   1) Convert aircraft to VTOL configuration and hover at low altitude.
   2) Determine aircraft response to moderate control inputs on all axes.
   3) Develop pilot proficiency with several liftoffs and touchdowns.
   4) Flight accomplished per card.

e) Flight Crabs
   None

f) Comments
   1) Pilot accomplished two liftoffs and touchdowns without incident. Winds were running 5-6 knots and temperature was 76°F. Pilot noted that ground effect poses no problem although some random lateral inputs are encountered.
   2) It was reported that less power is required to maintain hover out of ground effect than is required on either takeoff or landing in ground effect.

3) Pilot accomplished completely satisfactory longitudinal, lateral and directional translations of the aircraft. The aircraft was backed up, moved forward, sideslipped both ways, and yawed 90° to the wind without any problem. Pilot reported that pitch and roll controls are very powerful, that height control with the collective is good, and that yaw control, although somewhat weaker than the others, is satisfactory.

4) The test was terminated due to low fuel.

g) Instrumentation

PCM and telemetry were operated. Photo panel was not operated due to a camera malfunction.

12. Flight 12F was planned to continue hovering investigations.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 12F Date: July 23, 1964
Pilot: V. Schaeffer T.O. Time: 0810 PDT Flight Time: 15 Min.
T.O. Gross Weight: 10,200 lbs. C.G.: 239.94 in.

b) Work Accomplished Prior to Flight

1) Repaired wiring malfunction to photo panel camera.

2) Reloaded PCM tape transport.

c) Test and Configuration

1) VTOL hover.

2) Landing gear fixed in extended VTOL position.

d) Flight Plan and Actual Flight

1) Convert aircraft to VTOL configuration and hover at low altitude.

2) Determine aircraft response to small control inputs on all axes.

3) Develop pilot proficiency with several liftoffs and touchdowns.

4) The flight plan was not accomplished completely due to the occurrence of a structural overheat indication and a subsequent engine compressor stall.

e) Flight Crabs

Engine compressor stall encountered on No. 2 engine immediately prior to touchdown.

f) Comments

1) Liftoff was accomplished on first attempt, without incident, into a wind of 5-6 knots, with the ambient temperature at 77°F.
2) Pilot commented that aircraft is very easy to fly, that ground effect, although it does provide some random lateral inputs, is no problem, and that the control response in all axes is excellent.
3) Pilot noted that control forces are somewhat higher than a helicopter but that control response is better, and that overall result is an improved system to that encountered in helicopters. The aircraft can be trimmed to a nearly "Hands Off" condition in hover at 5-6 feet of altitude.
4) After one minute, forty-five seconds in hovering flight, the structural overheat light illuminated, necessitating termination of the test for cooling purposes.
5) As the aircraft was approaching touchdown, and while in ground effect at a height estimated at 2.5-3 feet, the compressor stall on the No. 2 engine was encountered. The engine power decreased instantaneously and the aircraft landed heavily, but without bottoming the gear struts. Due to an increased EGT condition, the engine was shut down immediately and no other damage was sustained by the aircraft. The engine will be removed for teardown inspection. The investigation of the stall problem is continuing.

g) Instrumentation

PCM, telemetry and photo panel were operated.

After pilot and engineer discussions, see Figure 36, the flight operations were halted and further compressor stall investigation started. Details of the stall investigation and resulting aircraft configuration are described in Section V-B, page 113.

Figure 36. Post Flight Briefing.

13. On August 15, 1964, after completing successful tie-down runs, Ship No. 2 resumed hover testing. No stalls have been experienced during all subsequent flights.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 13F Date: August 15, 1964
Pilot: V. Schaeffer T.O. Time: 0355 PDT Flight Time: 10 Min.
T.O. Gross Weight: 10,000 lbs. C.G.: 240.0 in F.S.

b) Work Accomplished Prior to Flight

1) Accomplished VTOL tie-down engine runs 12.01G through 12.16G, excluding 12.03G and 12.15G, to evaluate compressor stall modifications.

2) Accomplished horizontal thrust stand run 12.03G to determine horizontal VTOL thrust at 45° vector angle and to determine maximum power CTOL engine thrust.

3) Accomplished horizontal thrust stand run 12.15G to determine amount of engine thrust loss associated with compressor stall modifications.

4) Made the following compressor stall modifications:

(a) Reprogrammed the compressor bleed valves so that the valves would seek their full closed position at a higher RPM.

(b) Provided a stop on the compressor bleed valves to allow a minimum of 10% bleed valve opening.

(c) Drilled 3/8 inch holes around periphery of engine inlet to allow cool air from cooling holes on the top of the inlet to enter the inlet and cool the compressor blade tips.

(d) Installed an ejector which, by using compressor bleed air, pulls cool air over the outside of the compressor cases.

(e) Relocated engine T_2 sensors to more forward position in inlet.

(f) Biased T_2 sensors to effect bleed valve operation approximately 25°F earlier than previously.

5) Replaced R/H engine for teardown inspection necessitated by overtemperature condition caused by Flight 12F compressor stall.

6) Replaced pitch fan due to foreign object damage.

7) Provided instrumentation to record compressor inlet total pressure and temperature, compressor discharge and turbine discharge pressures.

8) Added 25 lbs. of ballast in tail section for C.G. control.

9) Aircraft weighed and horizontal and vertical C.G. determination was made.

c) Test and Configuration

1) Compressor stall check in hovering flight in ground effect.

2) Landing gear fixed in extended CTOL position.

d) Flight Plan and Actual Flight

1) 10 second hover in ground effect at 2-3 feet height with aircraft facing into wind.

2) 15 second hover in ground effect at 2-3 feet height with aircraft facing into wind.

3) 10 second hover in ground effect at 2-3 feet height with aircraft facing downwind.

4) Flight card was accomplished as planned.

e) Flight Crabs

None

f) Comments

1) Engine light-off was made at the hangar. Aircraft was then taxied to the hot gun line for the hover tests.

2) The hover tests were made as scheduled, with no compressor stalls being encountered. The object of this test was to obtain quantitative information regarding the engine operating environment while hovering in ground effect. The temperature was approximately 62°F and the winds were 5-6 knots.

3) This flight marks the first time that the aircraft has been hovered in ground effect for any prolonged period. The pilot commented that the collective control appears to be less effective in ground effect than out. Application and retardation of power

is necessary to provide precise altitude control in this region. The aircraft is felt to be easy to control, although definite pilot inputs are required to compensate for the random ground effect lateral inputs. The pilot also commented that the airplane is more sensitive to wind gusts in ground effect, but that control is no problem.

4) This flight was made with the main landing gear in the CTOL position, in order to evaluate the proposed single down position. No adverse heating effects were noted. As expected, the pilot reported a much more responsive pitch control on the ground with this gear position. Nose wheel liftoff occurs at a lower power setting and aircraft attitude at main gear liftoff is considerably higher. The same comments apply on landing.

g) Instrumentation

PCM and photo panel were operated. Due to a malfunction, the telemetry did not operate.

Figures 37 and 38 show aircraft control positions during Flight 13F.

14. Flight 14F, the second flight on August 15, 1964, completed flight activities for this quarter. The roll oscillation was determined to be a phase lag in the auto stab channel caused by a filter. This change, plus a mixer box change to reduce the collective lift stick authority, corrected the roll oscillation problem.

a) Ship No.: XV-5A S/N: 62-4506 Flight No.: 14F Date: August 15, 1964
Pilot. V. Schaeffer T.O. Time: 0750 PDT Flight Time: 10 Min.
T.O. Gross Weight: 9920 lbs. C.G.: 239.6 in F.S.

b) Work Accomplished Prior to Flight

1) Aircraft refueled.
2) Accomplished between flight inspection.

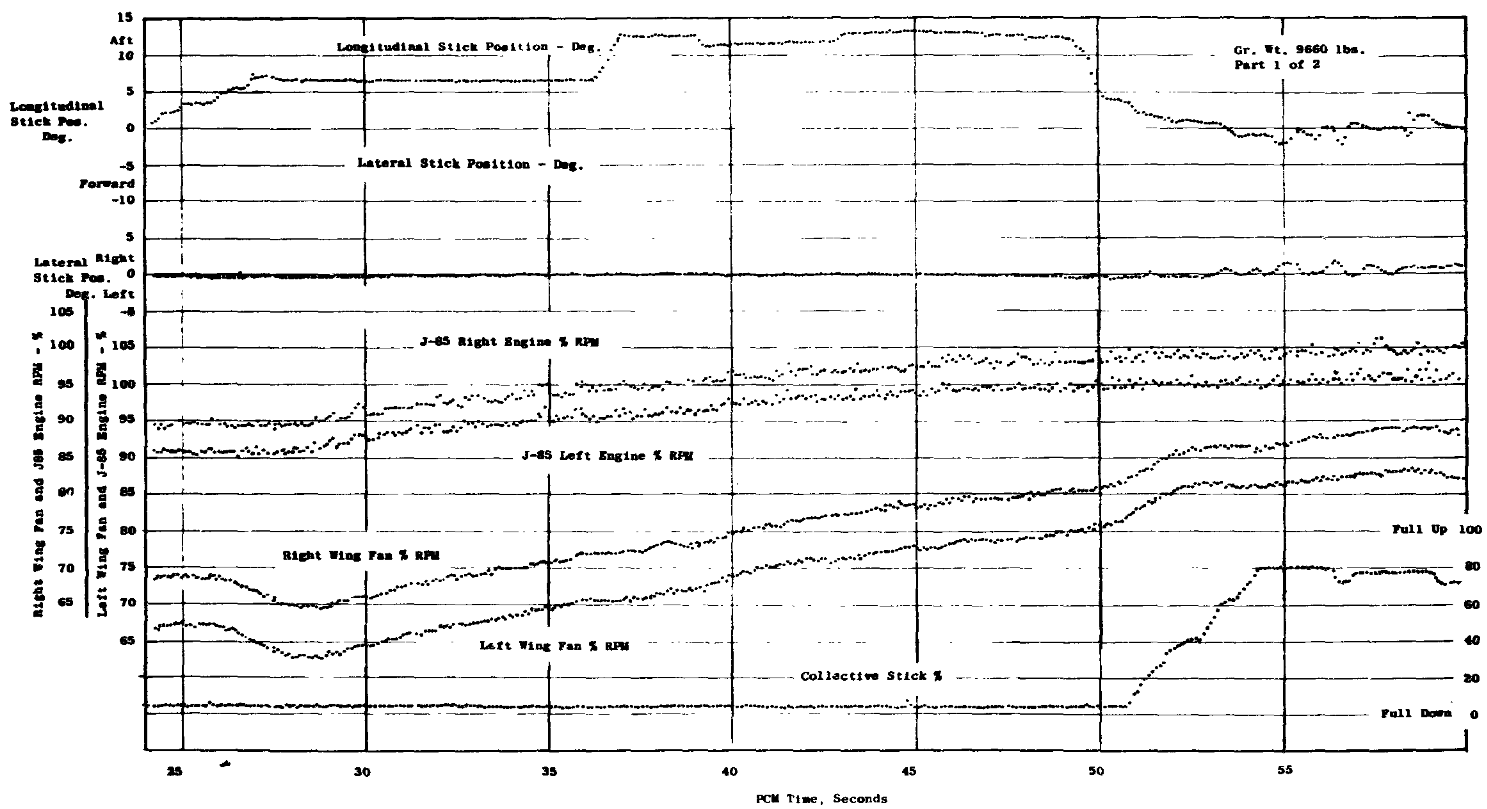


Figure 37. XV-5A S/N 62-4506 Hover Flight Test 13F, Hover No. 1.

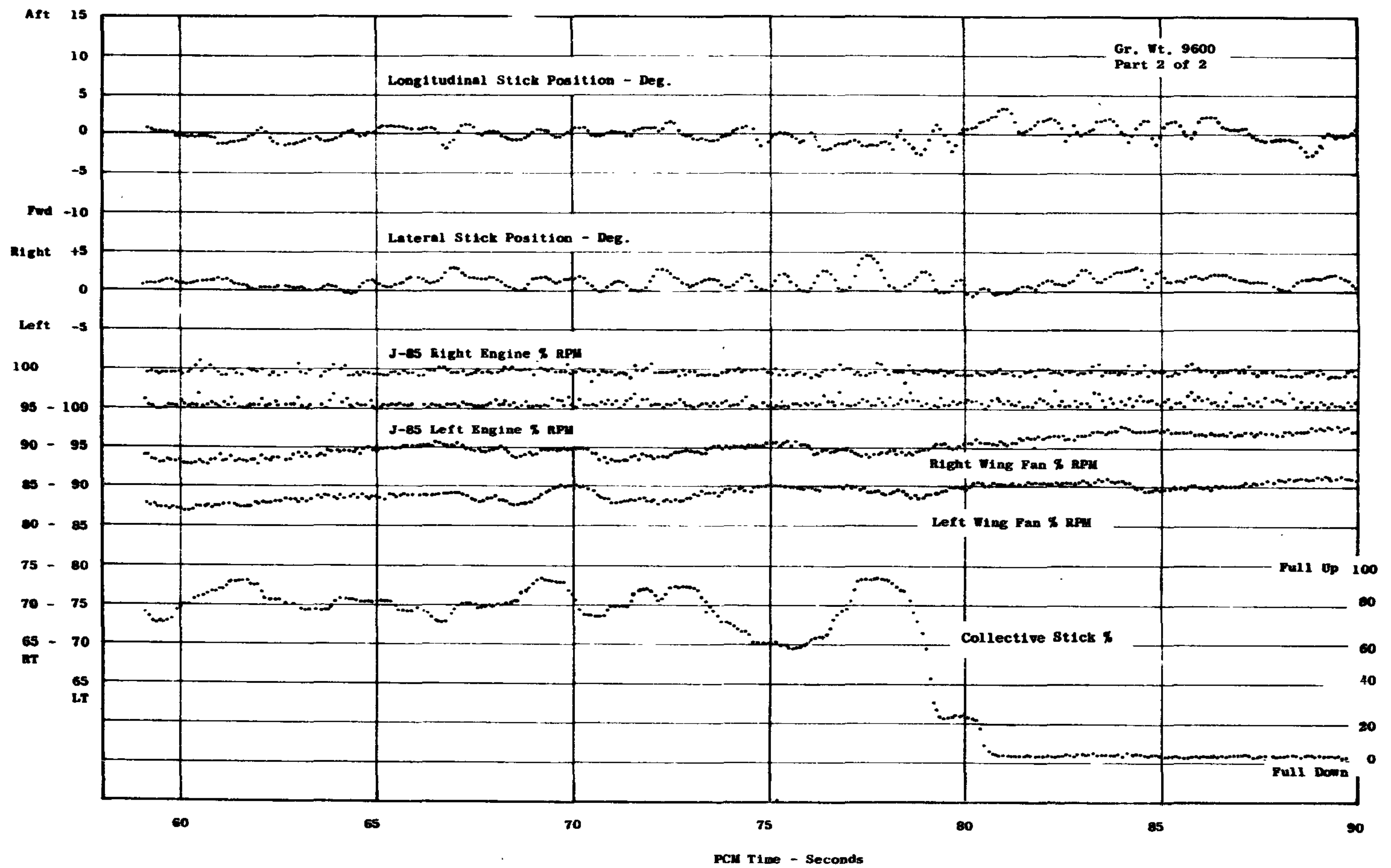


Figure 38. XV-5A S/N 62-4506 Hover Flight Test 13F, Hover No. 1.

c) Test and Configuration

1) Compressor stall check in hovering flight out of ground effect.

2) Landing gear fixed in extended CTOL position.

d) Flight Plan and Actual Flight

1) 10 second hover out of ground effect with aircraft facing upwind.

2) Repeat A for 30 seconds.

3) Repeat A for 45 seconds.

4) Repeat A for 60 seconds.

5) Flight card was accomplished as planned, with the exception that Item D was terminated after approximately 40 seconds, due to the flight crab noted below.

e) Flight Crabs

Auto stab roll oscillation occurred during last hover and appeared to be diverging slowly.

f) Comments

1) The four hovers out of ground effect were accomplished as scheduled, with no compressor stalls being encountered. The apparent auto stab problem precluded the completion of the last point

2) While the aircraft was being held in a stationary position on the last point, an approximately 1/2 cycle/second small amplitude roll oscillation developed. The aircraft was out of ground effect at about 7-8 feet altitude at the time. The pilot held the controls stationary to determine that an external input was involved. After a short period, it appeared that the magnitude was increasing, so the test was terminated. Landing was made without incident.

3) Pilot reiterated his comments of Flight 13F regarding the aircraft behavior with the more forward CTOL gear, and also the differences between operating in and out of ground effect. No new comments were made.

g) Instrumentation

PCM and photo panel were operated. Telemetry was inoperative.

Table IV is a tabulation of ground and flight test activity at Edwards Air Force Base for this period.

FLIGHT TEST SUMMARY - TABLE IV

DATE	FLT. NO.	SCHEDULED	T.O. TIME	FLT. TIME	PILOT	PURPOSE	REMARKS
25 May	1 F	0900	0936	0:20	Schaeffer	First flight, pilot familiarization.	Entire flight made with wing flaps extended. Arbitrary speed limitation of 150 KIAS. Excellent handling characteristics at these low speeds. Control forces were light and sensitivity was high. Good harmony of control. Static longitudinal stability was neutral to negative over this limited speed range with flaps extended.
26 May	2 F	0800	0836	0:25	Everett	Pilot familiarization. Static longitudinal stability. Trim changes.	Static longitudinal stability was positive with flaps retracted at the low airspeeds flown. Stick forces required to overcome trim changes due to change in configuration or power were not excessive. Good response to lateral control.
27 May	3 F	0800	0848	0:35	Schaeffer	Static and dynamic stability, 3 axes. Low speed.	Dynamic longitudinal stability was evaluated with L.G. extended, flaps 0 deg. The short period oscillation was deadbeat. The long period (phugoid) oscillation was positively damped, returning to trim in 1.5 cycles.
27 May	4 F	(0800 28 May)	1345	0:40	Everett	Static lateral-directional stability. Dynamic longitudinal stability. Static longitudinal stability.	Static lateral-directional stability was evaluated with flaps retracted. Wings level steady sideslips were satisfactory. Aileron and rudder "S" turns were easy to execute. Good control response was in evidence. Light control forces are required to overcome trim chgs.
28 May	- -	0800 (See 4 F)	----	----	----	-----	Flight activity suspended pending analysis of data attained to date.
29 May	- -	----	----	----	----	-----	No activity, Base Holiday.

FLIGHT TEST SUMMARY

DATE	FLT. NO.	SCHEDULED	T.O. TIME	FLT. TIME	PILOT	PURPOSE	REMARKS
1 June	4.01G	0900	1222	(0:15)	Everett	High speed taxi to evaluate spin chute deployment.	Chute deployed satisfactorily at 80 KIAS, however the chute did not stream properly. Wheel brakes became overheated and faded during the deceleration.
2 June	----	0800	----	----	----	Stall Approaches.	Takeoff time delayed in AM due to brake fade, (new pucks and drums after 4.01G). Second attempt to fly aborted in PM due to malfunction in chase T-37 aircraft.
3 June	5 F	0800	0844	0:35	Schaeffer	Static longitudinal stability and stall approaches.	C.G. location has relatively small effect on basic stability. At these low speeds, the stability appears to become + at flap settings below 20 degrees. Stall approaches were described as classical, buffet being followed by lateral wallow and finally by nose pitch down.
3 June	6 F	----	1420	0:35	Everett	Static longitudinal stability, stall approaches at 15, 30 and 45 degree flaps. Pre-conversion checks.	Static longitudinal stability basically neutral at 30 deg. flaps. Stall approaches yielded following indicated results: Flaps / Min. Speed / Angle Attack 15 deg / 100 KIAS / 23 deg 30 deg / 94 KIAS / 23 deg 45 deg / 91 KIAS / 23 deg Assuming the pre-conversion configuration, and flying in that regime presented no difficulties.
4 June	7 F	0800	0816	0:35	Schaeffer	Stall approaches. Pre-conversion check and stall approaches Lateral-directional stability.	Preconversion checks indicated no difficulties. Short period dynamic longitudinal stability was deadbeat. Pre-conversion stall approaches were satisfactory. Lateral-directional stability was satisfactory. Oscillation from rudder release damped out in 1-1/2 to 2 cycles.

FLIGHT TEST SUMMARY

DATE	FLT. NO.	SCHEDULED	T.O. TIME	FLT. TIME	PILOT	PURPOSE	REMARKS
5 June	8 F	0630	0638	0:40	Everett	Low Speed Airspeed Calib.	8 paced points between 93 and 160 KIAS obtained. 3 tower fly-bys between 120 to 150 KIAS obtained.
16 July	9 F	0630	0855	0:25	Everett	Hover Test.	Initial hover test conducted at Hot Gun Line Area. G.W. 9500-9200 lb. Temp. 81°F. Five lift-offs conducted. Fifth lift-off to approximately 3-5 feet. A/C stable. Test objectives accomplished. Controls satisfactory.
17 July	10 F	0630	0608	0:05	Everett	Hover Test.	Hover conducted at Hot Gun Line Area. G.W. 9800 lb. Temp. 68°F. One lift-off conducted. A/C very stable and controllable above 4 foot height. Compressor stall after touch-down precluded further testing.
20 July	- -	0800	----	----	----	Engine Runs in tie-down area.	Not accomplished. A/C in preparation for tests.
21 July	10.01G	0630	0725	(1:47)		Engine Runs in tie-down area.	Runs made in single engine operation as well as two engine operation to check out each engine in both jet and fan mode. A check was also made to evaluate single system hydraulic operation. Results satisfactory.
22 July	- -	0630	----	----	----	Hover Operation.	Test Cancelled, winds too high.
23 July	11 F	0630	0647	0:35	Everett	Hover Operation.	Two lift-offs, hover and landings accomplished. First hover approx. duration 3 min. Second hover approx. duration 2 min. Pitch and roll control powerful, yaw control not as responsive. Aircraft very stable and maneuvering rates steady.

FLIGHT TEST SUMMARY

DATE	FLT. NO.	SCHEDULED	T.O. TIME	FLT. TIME	PILOT	PURPOSE	REMARKS
23 July	12 F	----	0809	0:16	Schaeffer	Hover Operation.	First hover operation by Schaeffer. Duration approx. 2 min. Good lift-off and control response. Structural overheat light ON dictated landing. Compressor stall on No.2 engine when A/C approx. 2-3 feet off ground. A/C settled heavily, but struts did not bottom out, slight bounce. Test then terminated.
24 July	- -	0700	----	----	----	Engine Runs for Compressor Stall Investigation.	Test rescheduled for 25 July. A/C and instrumentation not in readiness.
25 July	12.01G	0700	----	(0:37)	Everett	Compressor Stall Investigation.	Numerous aircraft problems precluded run completion. Pitch fan frame overheat light, diverter light failure, FOD in R/H wing fan.
27 July	12.02G	0900	0907	(0:29)	Scheaffer	Compressor Stall Investigation. (Tie-down Area)	Three compressor stalls encountered at 100% RPM during conduct of test procedures suggested by GE during VTOL mode of operation.
27 July	12.03G	1400	1438	(0:28)	Schaeffer	Static Thrust Check on CTOL Thrust Stand.	Static thrust check was made in both CTOL and VTOL modes of operation on EAFB CTOL static thrust stand. Preliminary results at 100% RPM at 100°F and 27.53"HG as follows: VTOL (45° B_V) 5400 lb.; CTOL 4400 lb.
28 July	- -	----	----	----	----	Weights and Balance.	During analysis of compressor stall data, the A/C was sent to weights & balance hangar and the vertical c.g. was determined in a defueled condition.
29 July	- -	----	----	----	----	No test activity scheduled	Compressor stall data being analyzed.
30 July	12.04G	0800	0902	(0:45)	Schaeffer	Compressor Stall Investigation (Tie-down Area)	No compressor stalls encountered during conduct of test procedures suggested by GE (VTOL).

FLIGHT TEST SUMMARY

DATE	FLT. NO	SCHEDULED	T.O. TIME	FLT TIME	PILOT	PURPOSE	REMARKS
30 July	12.05G	----	1517	(0.24)	Everett	Compressor Stall Investigation (Tie-down Area)	Two compressor stalls encountered, one each at 100% and at 95% RPM during conduct of test procedures suggested by GE (VTOL).
31 July	12.06G	1000	1458	(1 05)	Everett	Compressor Stall Investigation (Tie-down Area)	Two compressor stalls encountered on No.2 engine at -5° B_v angle with full right stick and rudder at full aft stick displacement. Collective was at mid and minimum positions respectively at 100% RPM.
3 Aug.	- -	----	----	----	----	----	No test activity scheduled. A/C in work status for instrumentation installation.
4 Aug.	- -	----	----	----	----	----	No test activity scheduled. A/C in work status for modifications to engine inlet duct geometry.
5 Aug.	12.07G	1000	1302	(0:19)	Everett	Compressor Stall Investigation (Tie-down Area)	Runs made at -7° B_v angle at engine RPMs of 100% and 102% at minimum collective. Runs were conducted with instrumented inlet screen installed. No stalls were encountered.
5 Aug.	12.08G	----	1354	(0:09)	Everett	Compressor Stall Investigation (Tie-down Area)	Runs made at 100% RPM at maximum collective with B_v in 10° increments from 0° to 30°. Runs were conducted with instrumented inlet screen installed. No stalls were encountered.
6 Aug.	12.09G	0900	1343	(0:36)	Schaeffer	Compressor Stall Investigation (Tie-down Area)	Runs made at 100% RPM at minimum collective at $B_v = -7°$, after resetting bleed valves. Runs were conducted with instrumented inlet screen installed. No stalls were encountered. Additional tests were precluded by faulty R/H generator.

FLIGHT TEST SUMMARY

DATE	FLT. NO.	SCHEDULED	T.O. TIME	FLT. TIME	PILOT	PURPOSE	REMARKS
7 Aug.	12.10G	0800	0833	(0:48)	Everett	Compressor Stall Investigation and Auto-Stab System Check (Tie-down Area)	Auto-Stab system checked out satisfactorily. Bleed valves checked out OK. Compressor stall checks made at max. collective at 100% RPM with varying B_V and at minimum collective at 100% RPM at -7° B_V with alternate inboard louver tips removed. No stalls were encountered. Instrumented inlet screen was installed.
7 Aug.	12.11G	----	1409	(0:29)	Schaeffer	Compressor Stall Investigation (Tie-down Area)	Runs made at 100% RPM with varying B_V at max. collective, and at 102% RPM at B_V = -7° at min. collective with alt. tips removed. No stalls encountered. Inlet screen was installed.
15 Aug.	13 F	0615	0636	0:10	Schaeffer	VTOL Hover.	Three hovers conducted in ground effect with winds approx. 5-6 knots. Landing gear was in CTOL position because of nature of test. No stalls were encountered. G.W. range 9700-9200 lbs.
15 Aug.	14 F	----	0744	0:10	Schaeffer	VTOL Hover.	Four hovers conducted out of ground effect with winds approx. 5-6 knots. Landing gear in CTOL as for 13F. No stalls were encountered. Roll oscillation was encountered during last hover. G.W. range 9800-9300 lbs.

B. J85/XV-5A STALL INVESTIGATION

A chronological history of all XV-5A compressor stalls and engine runs specifically to investigate stalls is shown in Table V.

The first compressor stall encountered in the XV-5A installation occurred during systems functional checks at Ryan, San Diego. The stall occurred during a fan mode run on single engine and with a strong cross wind. No over-temperature condition following shutdown was noted, and inspection revealed no damage. Subsequent running in similar conditions failed to produce another stall and no further action was taken at that time.

During the third ground run for modified exit louver actuation system checks, the first compressor stall on Aircraft Number 2 occurred, in conditions of high ambient temperature. Normal compressor stall recovery procedure, consisting of a throttle drop to idle, was used and a successful recovery followed. Additional stalls were encountered on subsequent runs.

Instrumentation on the J85 inlet up to this point consisted of three thermocouples evenly spaced in each J85 inlet, but recorded through a stepper switch, which gave a temperature reading at five-second intervals. This was changed to permit direct recording of all six temperatures during VTOL thrust stand runs. In addition, pressure rake survey instrumentation was added.

Following completion of the Edwards VTOL thrust stand thrust measurement, attempts were made to induce compressor stalls. Various combinations of full control throw were used, with stabilized time intervals of fifteen seconds, a condition felt to be representative of flight conditions (or worse). No stalls were encountered. At the last of the running time, a check was made of the anti-icing valve (energized position is cold air). Following completion of this check, a stall occurred in the right hand engine. No recovery could be made. The engine rotor was seized following shutdown. On teardown inspection of the rotor, a failed thrust bearing was found. Since this would permit a change of clearance between compressor rotor and stator, it was felt that the bearing failure probably induced the stall.

TABLE V

XV-5A NO. 2 COMPRESSOR STALL HISTORY

						STALL CONDITIONS									
				WINDS				CONTROL POSITION							
STALL NO.	RUN NO.	RUN PURPOSE	Ta	Deg. to Nose	STALLED ENGINE	RPM	Bv	COLL.	LONG.	LAT.	RUDDER	RECOVERY	ENGINE MODIFICATION	INSTRUMENTATION ADDITIONS	REMARKS
1	8.03G	Louver Mod. Checks	-	10-15K at 120°	#1	100%	0	Mid	Neut	Neut	Neut	Throttle chop-good	None	None	First stall encountered on #2 A/C.
2	8.04G	Louver Mod. Checks	-	-		100%	0	Mid	Neut	Left	Left	Throttle chop-good			
3						100%	0	Mid	Neut	Left	Left	Throttle chop-good			
4						100%	0	Mid	Neut	Left	Left	Throttle chop-good	None	None	
5	8.05G	Louver Mod. Checks	-	-	#1	100%	0	Mid	-	-	-	Throttle chop-high EGT - good	None	None	
6	8.15G	Compressor Stall Checks	95°F	3-4K at 120°	#2	95%	0	Mid	Neut	Neut	Neut	Engine flamed out and seized	Replaced #2 engine	None	Anti-icing cycled immediately preceding stall.
7	10F	Hover Flight	69°F	2K at 0°	#2	95%	-5	1/4 Up	Neut	Neut	Neut	Throttle chop-good	None	None	Stall occurred on and just after touchdown. Opened RH eng. fan scroll area 2 notches. Set top speed on both engines to 102% N. Stall occurred in hover at 2.5 - 3 feet.
8	12F	Hover Flight	77°F	5-6K at 0°	#2	99%	-5	Min	Neut	Neut	Neut	Delayed throttle chop - engine shutdown by EGT overlimits (>950°)	1) Replaced #2 engine 2) Reset #2 engine fuel density to slightly higher value. 3) Trimmed #2 engine	1) Instld T_2 sensor temp. 2) Eng. Compressor case temps. 3) Bleed valve positions 4) T_t-2 (inlet duct temp)	
9	12.02G	Compressor Stall Checks	-	5-K at 340°	-	100%	0	Mid	Neut	Neut	Left	Throttle chop-good			
10					#1	100%	0	Mid	Neut	Neut	Left	Throttle chop-good			
11						100%	0	Max	Neut	Right	Right	Throttle chop-good	1) Instld scoop to duct air to T_2 sensor 2) Added 6 holes in air condition duct to provide cooling air to compressor cases. 3) Returned fuel density setting on #2 engine to original.	1) Instld T/C's to record eng. compr. case compt air temps.	
	12.04G	Compressor Stall Checks													No stalls encountered.

TABLE V (Continued)

XV-5A NO. 2 COMPRESSOR STALL HISTORY

STALL NO.	RUN NO.	RUN PURPOSE	Ta	WINDS Deg. to Nose	STALLED ENGINE	STALL CONDITIONS RPM	Bv	CONTROL POSITION COLL.	LONG.	LAT.	RUDDER	RECOVERY	ENGINE MODIFICATION	INSTRUMENTATION ADDITIONS	REMARKS
													1) Plugged 6 holes drilled in air conditioning duct		
12	12.05G	Compressor Stall Checks	99°F	18-27K at 330°	#2	100%	0	Min	Neut	Right	Right	Throttle chop-good			
13					#1	100%	0	Min	Fwd	Left	Neut	Throttle chop-good			
													1) Adjust bleed valves to open at higher RPM 2) Adjusted bleed valves to maintain 1/10 open minimum		1) Lengthened bleed valve racks 4 turns LH eng. 3 turns RH engine. 2) Shortened feed back cable 3 turns both engines.
14	12.06G	Compressor Stall Checks	93°	20K at 270°	#2	102	-5	Mid	Aft	Right	Right	Throttle chop-good			1) T_2 bellows adjusted A) LH removed .047 shim B) RH 1 turn in on Allen head.
15			93°		#2	102	-5	Min	Aft	Right	Right	Throttle chop-good			
													1) Biased both T_2 inlet sensors to effect bleed operations~25°F earlier than before. 2) Provided 62 holes in inlet duct to allow outside air into inlet 3) Relocated T_2 sensor to pos. fwd of holes provided in 2) above 4) Instld eng. inlet screen	1) Instld 34 T/C's on inlet screen 2) Instld 4 T/C's in inlet at new cooling air inlets 3) Instld 6 Pt2 probes 4) Instld Pt5 probe	T_2 sensor bias was 100° instead of 25°.
	12.07G 12.08G	Compressor Stall Checks													No stalls encountered
													1) Reset engine bleed valves to proper position. Runs 12.07G and 12.08G no good due to improper setting		T_2 bellows adjusted A) LH installed .025" shim. B) 3/4 turnout on Allen head on RH. This gave 45°F bias.
	12.09G 12.10G	Compressor Stall Checks											1) Removed alternate inboard wing fan louver tips during run 12.10G		No stall encountered.
	12.11G	Compressor Stall Checks											None		
	12.12G 12.13G 12.14G	Compressor Stall Checks											1) Reinstalled louver tips 2) Installed ejector to pull cooling air across compressor cases.		No stall encountered No stall encountered

Additional checks of engine vibration, and inspection of oil sumps on a recurring cyclic basis were initiated in order to better check for possibility of deteriorating thrust bearings during subsequent engine running.

Initial hover flights 9F and 10F were then completed. On touchdown after Flight 10F, a compressor stall occurred at about 95% J85 RPM. Recovery was good.

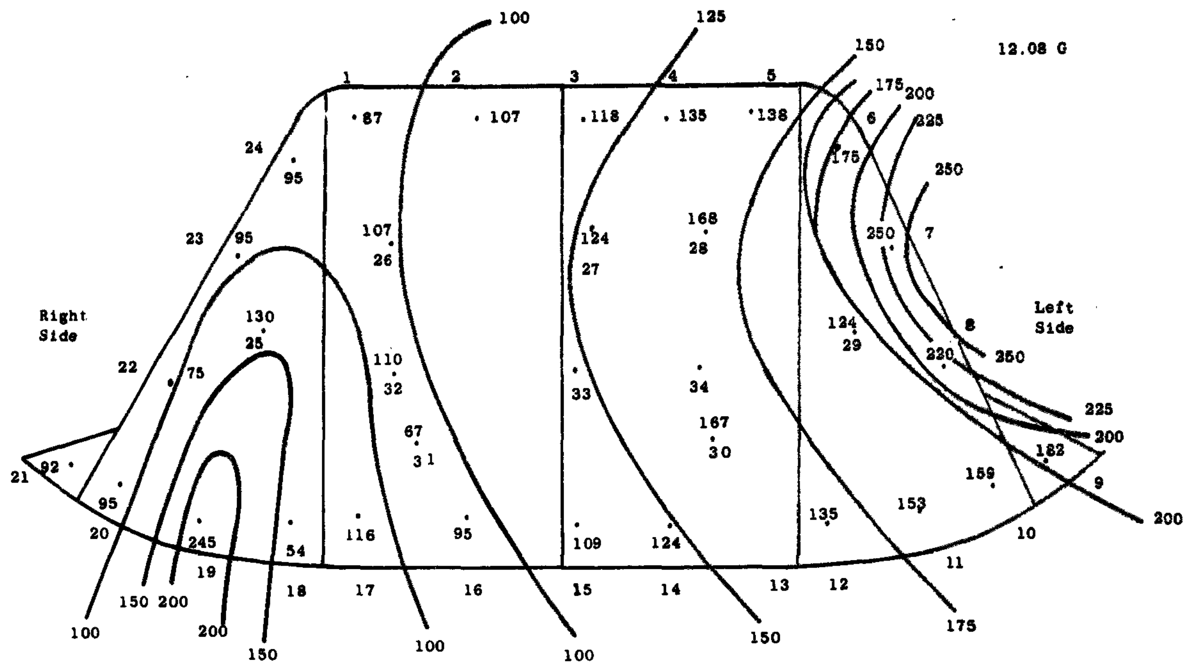
Following this stall, engine schedules were readjusted from 100% maximum physical J85 speed to 102% physical J85 speed. The J85 engine compressor characteristic is such that minimum stall margin is at about 95% $N/\sqrt{\theta_2}$ (engine speed corrected for ambient temperature). Since the J85 can run continuously at physical speeds up to 104% of design rate, corrected speeds at 102% physical and average 90°F would give additional stall margin.

On Flight 12F, while letting down for a hovering landing, a compressor stall occurred at two to three feet altitude. Recovery from the stall was not completed before the engine went over design temperature.

At this time, a complete set of J85 inlet pressure and temperature survey instrumentation was installed and a series of runs initiated to determine the extent of inlet condition variation.

Control combinations were determined which would induce temperature rise of up to 200°F in four to six second time intervals (and would also cause compressor stalls). Additional temperature measurements were made through a screen over the J85 inlets. A typical distribution of temperatures is shown in Figure 39. Other instrumentation was added to determine compressor casing temperatures (Δt giving an indication of change in compressor rotor/stator clearance), compressor and turbine gas pressures, bleed port pressures, bleed valve positions, fuel control T_2 sensor air temperature and others.

Specific changes were then made to increase the capability of the J85 XV-5A engine installation to compensate for high inlet temperatures and distortions associated with operation in ground effect.



Approximately
$T_{Local} - T_{Amb}$ (^oF)
$T_{Amp} = 102^oF$

<u>Controls:</u>
UP Collective
+30° Vector
Neutral Lat. Stick
Neutral Rudder
Aft Pitch

Figure 39. J85 Inlet Screen Temperatures.

Problem areas leading to decreased stall margin were:

a) Inlet temperature distortion.

b) T_2 sensor errors (original T_2 sensor air was supplied to the fuel control through a flush grille-covered inlet in the side of the J85 inlet (Figure 40).

c) Compressor casing temperatures - Corrective actions were taken, based on the previously determined discrepancies and in order to increase basic stall margin, changes were:

1) Increased airflow over T_2 sensors. See Figure 41 for redesigned sensor pickup. Sensor pickups are now located at the point of highest measured inlet temperatures (reingestion temperatures) and ahead of induced inlet air.

2) Introduced cool film or air into engine inlets and to compressor blade tips (see Figure 41).

3) Trimmed engines to rate power at 102% N_G.

4) Adjusted variable geometry for 5% open bleeds or more during all operations, plus adjusted bleed valve schedule for cold drag response (see Figures 42 and 43).

5) Introduced cooling air to compressor compartment to cool compressor casing and stabilize temperatures. An ejector system using compressor discharge bleed was utilized as the means of moving the cooling air (see Figure 44).

Specific goal of the various changes was to increase the stall margin and temperature distortion response of J85 without sacrificing installed power. Estimated performance changes are:

1)	Engine trim at 102% - - -	
2)	Variable geometry adjustment	-2.0%*
3)	Ejector for compressor case cooling	-.2%
		-2.2%

*Below 80°F T_{t_2} - See Figure 43.

Figure 40. Original T_2 Sensor Pickup.

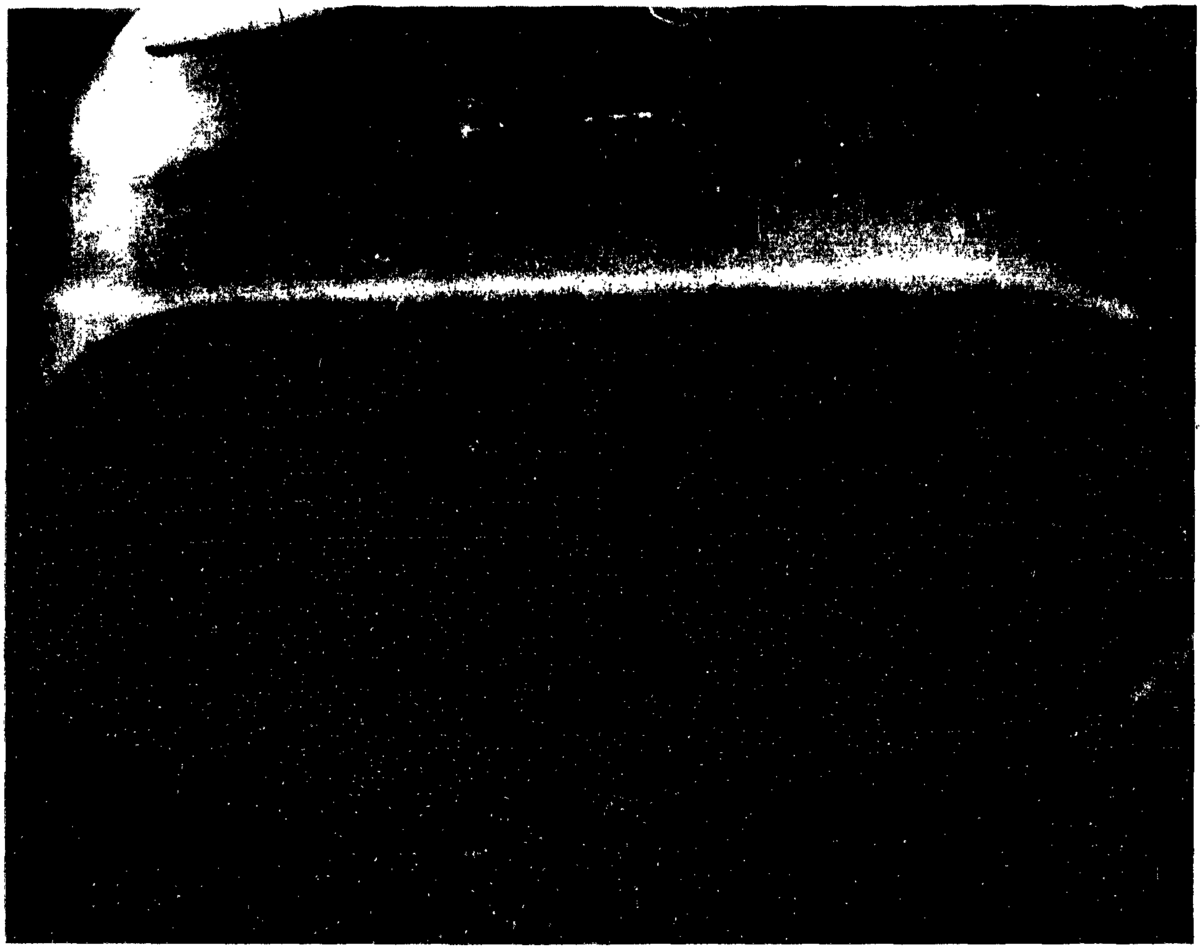


Figure 41. Modified J85 Inlet.

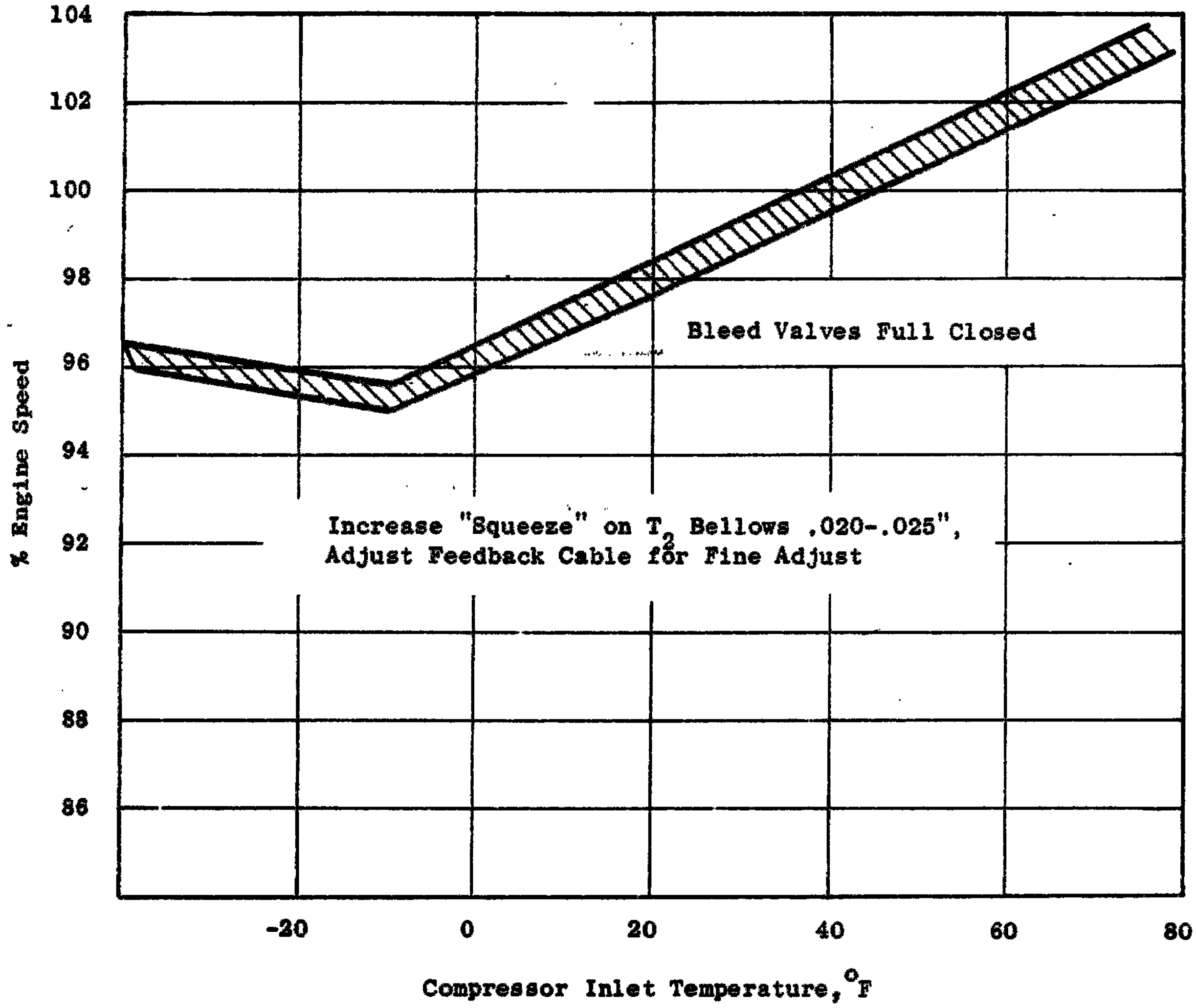


Figure 42. Special VG Trim for XV-5A.

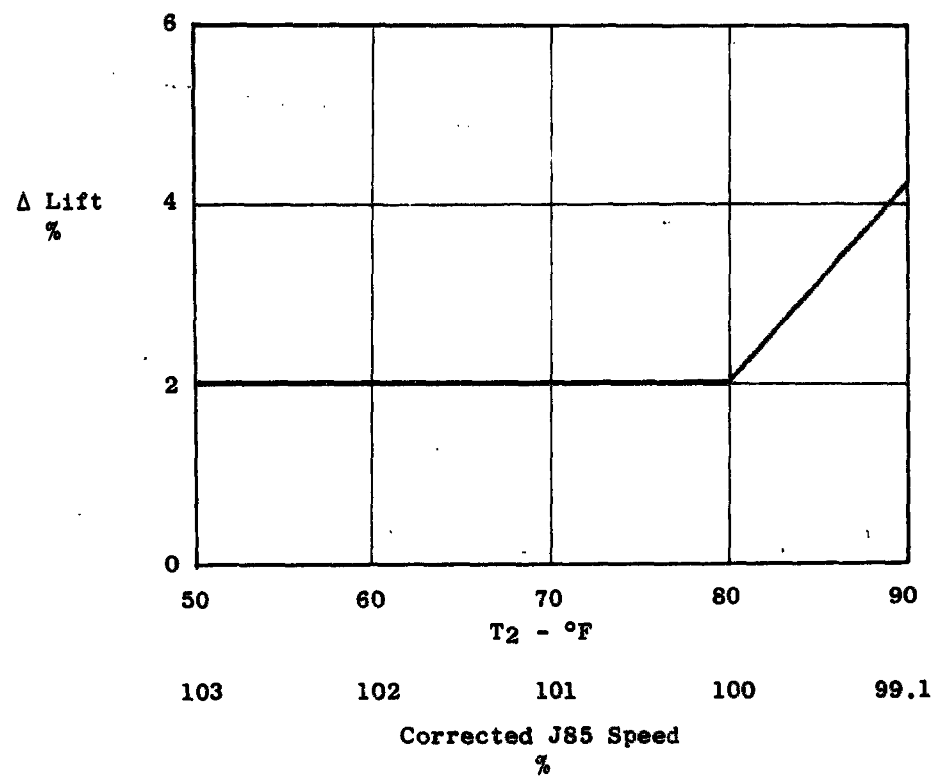


Figure 43. VG Adjustment - Effect on Performance - Predicted Decrement Based on SAED Engine 100-A. T_5 = 680°C - Max. Power.

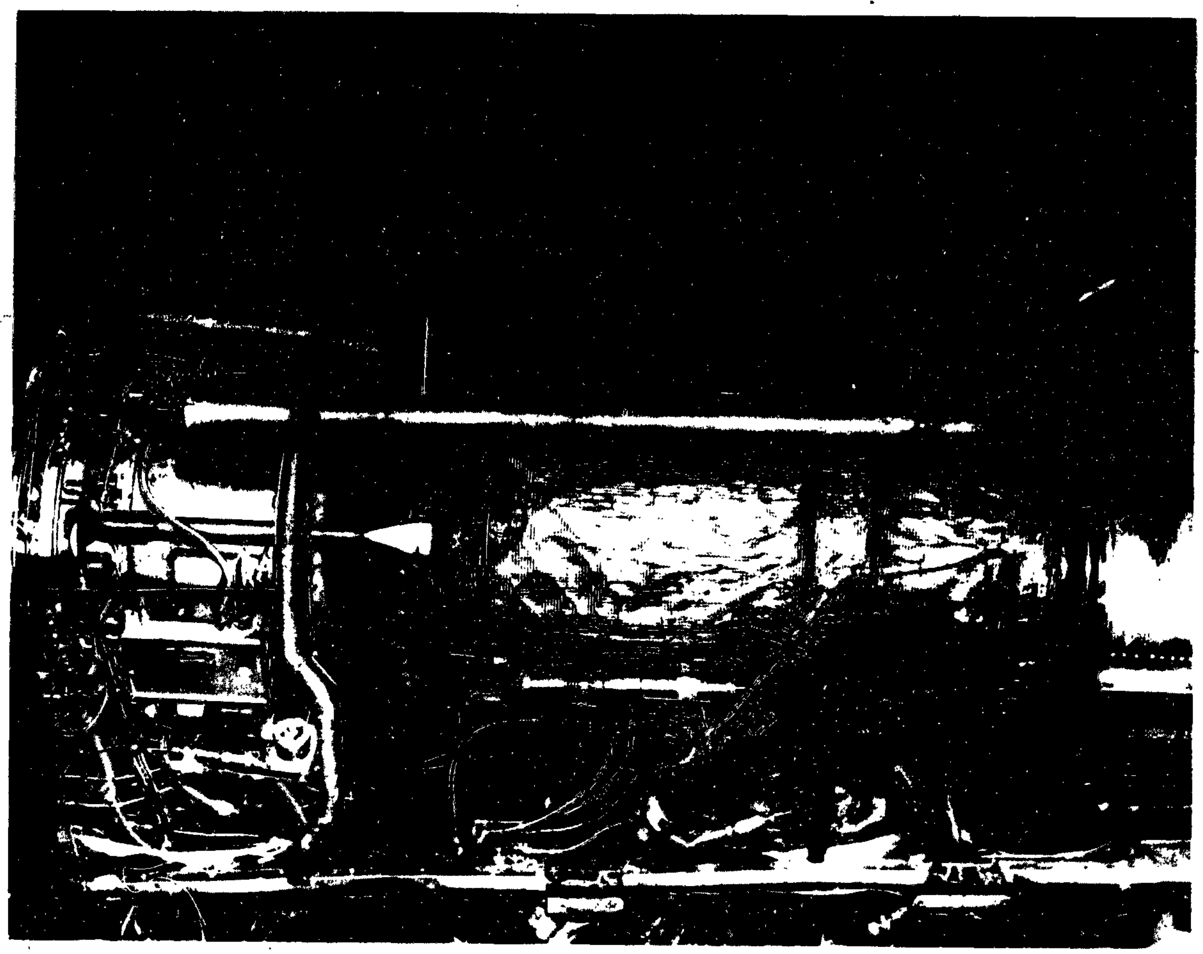


Figure 44. Cooling Ejector.

Following completion of all adjustments, ground runs were made to previously determined conditions, which would cause highest rate inlet temperature rise (reingestion) and maximum temperature rise. At the close of the reporting period, no further stalls have been encountered during three hours of ground running and five additional fan mode flights.

Plans for work to be done during the next reporting period include an analysis of measured flight environments, measured propulsion systems temperature parameters, and checks of changes designed to reduce the installed power losses, while maintaining an adequate stall margin.

C. J85 ENGINE AND FAN RUNNING HISTORY

Running times as of the end of the reporting quarter are listed in Tables VI and VII.

TABLE VI

J85 RUNNING RECORD

Engine S/N	Prior Hrs.	Since P.I. Hrs.	Ryan Hrs.	Edwards Hrs. Ground	Edwards Hrs. Flight	Status
230-729	79:16*	28:24	8:23	15:26	4:35	In repair after bearing failure.
230-730	80:40*	41:20	9:29	26:11	5:40	Installed in #2 A/C.
230-875	---	34:20	10:18	24:02**	0	Installed in #1 A/C.
230-876	---	35:19	9:15	26:04**	0	Installed in #1 A/C.
231-230	---	0	0	0	0	New
231-231	---	0	0	0	0	New
231-232	---	7:07	0	6:47	0:20	Installed in #2 A/C.
231-233	---	3:25	2:41	0:45	0	In repair for stall overtemperature.

* Includes running time from flightworthiness test

** NASA-Ames hours

TABLE VII

FAN RUNNING TIME - LIFT FANS

Fan S/N	Status	Ryan Hrs.	NASA Hrs.	Edwards Hrs. Ground	Edwards Hrs. Flight
003L	Spare, Edwards	0	0	0	0
004R	#2 Aircraft	3:25	0	7:46	1 05
005L	#1 Aircraft	1:06	22:14	0	0
006R	#1 Aircraft	1:06	22:14	0	0
007L	#2 Aircraft	3:25	0	7:46	1:05
008R	Spare, Edwards	0	0	0	0

FAN RUNNING TIME - PITCH FANS

001	#2 Aircraft	0	0	0:05	0:20
002	FOD, in repair	1:06	17:08	0:34	0
003	FOD, in repair	3:25	0	6:57	0:45

VI. MILESTONE COMPLETION SUMMARY

Number	Milestone	Revised Planned Date	Actual Date	Anticipated Date
94	Deliver Instructions for Operation and Maintenance of Airplane and Sub-system.	1/15		11/15
77.4	Complete thrust stand and pre-flight tests on No. 2 Aircraft.	1/17	5/20	
70.1	No. 1 airplane returned for flight test.	2/29	7/22	
79.2	All flight clearance reports submitted for high speed conventional flight.	2/29		10/26
78	Request flight clearance, low and high speed, for No. 1 Aircraft.	3/9		9/11
79.3	Request flight clearance, high speed for No. 2 Aircraft.	3/9		10/26
89	Start flight program on No. 1 Aircraft.	3/13		10/14
78A	Government approval and flight clearance of No. 1 Aircraft.	3/16		9/23
79B	Government approval and flight clearance, high speed, No. 2 Aircraft.	3/16		11/1

Number	Milestone	Revised Planned Date	Actual Date	Anticipated Date
76.2	Complete pre-flight tests on No. 1 Aircraft.	3/23		10/13
87	Demonstrate vertical takeoff and transition to wing supported flight and from wing supported flight to fan support and vertical landing.	4/17		11/9
71	Complete analysis of full scale wind tunnel data.	4/30		11/15
88	Demonstrate aircraft structural integrity throughout approved flight envelope.	6/10		11/22
90	Complete Flight Test Program.	6/26		11/22
93	Complete modifications to both aircraft to final flight configurations.	7/3		12/1
44	Complete any minor modifications in propulsion system and pitch fan system required during flight test.	7/15		12/1
41	Complete engineering and maintenance support of propulsion systems during the flight test program.	7/17		12/1
91	Complete preliminary analysis of flight test data.	7/17		11/22

Number	Milestone	Revised Planned Date	Actual Date	Anticipated Date
47	Complete reliability and failure analysis.	8/15		12/15
92	Submit substantiating data to enable Government flightworthiness evaluation for subsequent testing by Government pilots.	8/15		12/15